

The Journal of
Laryngology and Otology

The Journal of Laryngology and Otology

EDITED BY
WALTER HOWARTH

WITH THE ASSISTANCE OF
W. M. MOLLISON

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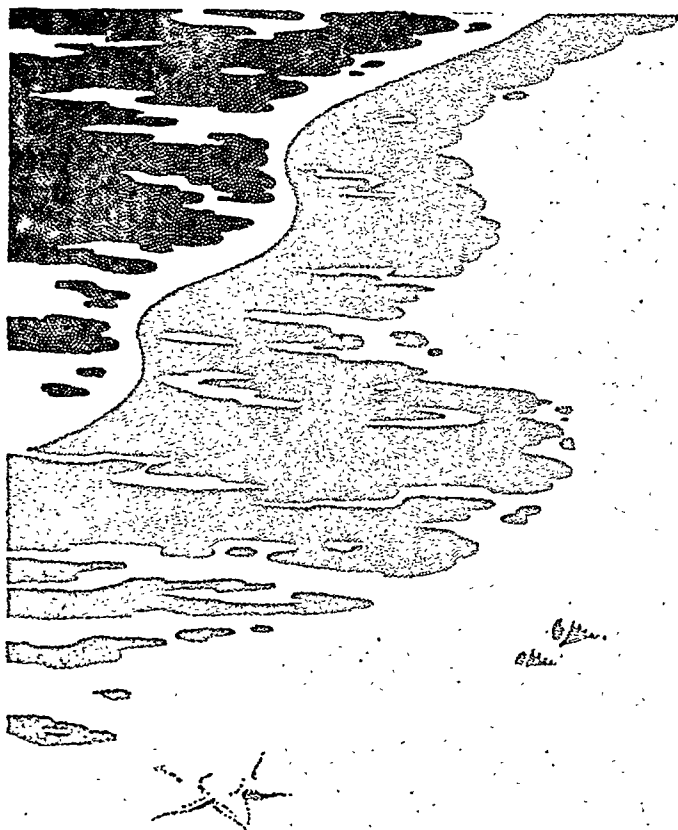
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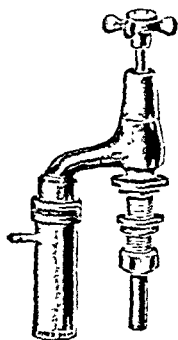
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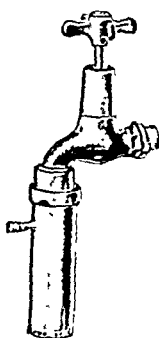
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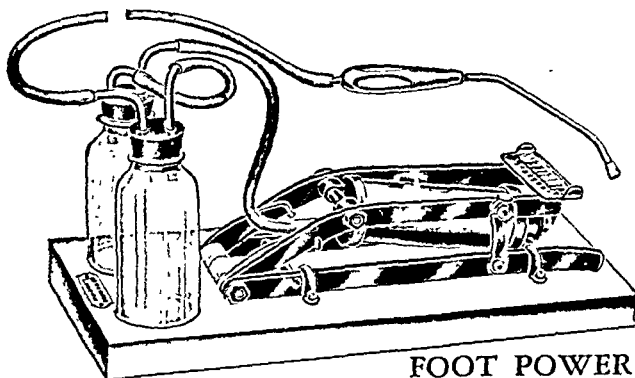


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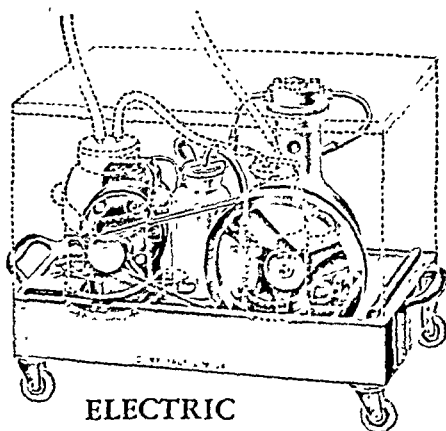
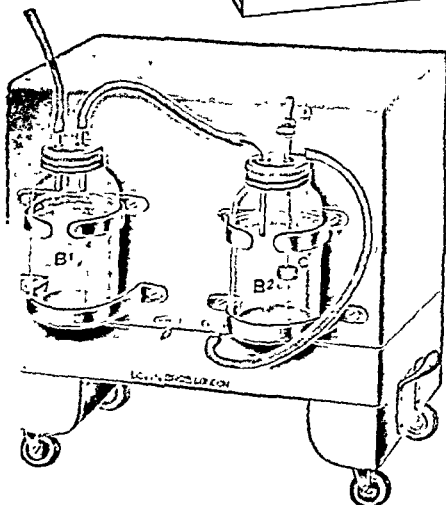


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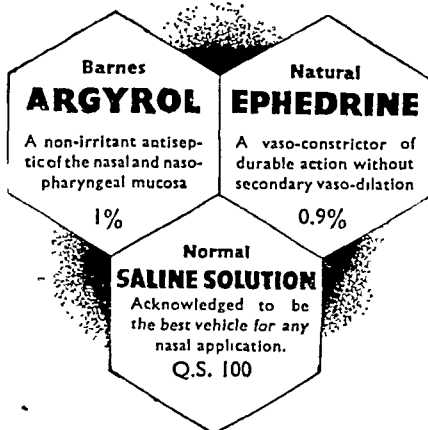
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January 1943

ADVANCES IN THE STUDY OF HEARING

By F. C. ORMEROD (London)

THE sense of hearing is one of extremely complex character and has been evolved out of a primitive defensive mechanism which served to distinguish long waves of low frequency, heralding the approach of danger or of food. Evolution has converted this very simple apparatus into an instrument which is capable of detecting and identifying sound waves from a lower level of 16 to an upper level of some 20,000 cycles per second, and it is at the same time able to appreciate a sound wave with a degree of intensity which is ten times less than the lowest intensity that can be appreciated by the eye. In addition to this capacity for discrimination of degree and range of sounds, the ears working together are able to localize the direction whence sounds come with a considerable amount of accuracy.

The ear possesses an analytical faculty which is probably much more advanced than that of any of the other senses. It can listen to the conversation of one individual of a large group and whilst being undisturbed by the general noises around, also take notice of what second and third persons are saying. A suitably trained observer can listen to a full symphony orchestra of several scores of performers, can identify the sounds produced by the various instruments, and would detect errors made by one of them. In the midst of a heavy barrage of artillery fire, with the noise of the muzzle expansion, of the explosion of bombs and shells, and the whine of falling projectiles, it is possible to detect a variation in the rhythm of an aeroplane engine many thousands of feet above, or of the passage of an automobile along the street. There are many examples of optical and tactile illusions, but the auditory is a more critical and more reliable sense, and auditory illusions are rare. This comprehensive and selective power cannot be achieved without a

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F. C. Ormerod

very efficient if somewhat complicated apparatus being evolved and the auditory mechanism is one that has given rise to a great deal of thought, clinical investigation and experimental research.

It is not my purpose to dwell on the history of the study of hearing, except perhaps to mention the early work of Cotugno, Sir Charles Bell and Helmholtz. There are few things, however, that escaped the early Chinese philosophers and in the writings of Confucius who lived five centuries before Christ one finds the statements :

" The blind have the best ears
and the deaf the sharpest eyes."

and again

" He who looks at the sun is dazzled,
He who hears thunder is deafened."

which must be one of the earliest references to auditory fatigue or concussion. My intention is to recall the various observations that have been made on the psycho-physiology of hearing during the past two decades and if possible to make some assessment of the effect they have had on our understanding of the problem. I have always found the physics of sound and the physiology of hearing of extreme interest and also of difficulty. There are times when a certain quatrain of Omar Khayyam has seemed very appropriate :

" Myself when young did eagerly frequent
Doctor and saint and heard great argument
About it and about, but evermore
Came out by the same door as in I went."

At the beginning of my period of twenty years the resonance theory of Helmholtz seemed to have been finally placed on the pedestal of certainty, Albert Gray had described the variable stria vascularis, the variation in mass and tension of the basilar fibres and had enunciated his theory of maximal stimulation. George Wilkinson had perfected his model of the cochlea, which by experiment and by mathematical calculation seemed—with Gray's observations—to have fully confirmed Helmholtz's original theory. Wrightson and Keith had sung what appeared to be the swan song of the telephone theory of Voltolini and Rutherford.

There were still difficulties and critics of the accepted theory and investigators in many different countries have been working out the behaviour of the various integral structures of the ear and its surroundings. It may be useful to consider these investigations, not in their chronological order but in turn, according to the various parts of the auditory mechanism with which they are concerned.

The passage of sound waves from the outside air to the endolymph of the cochlea may utilize many channels, and I would refer to a diagrammatic

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representation of these various routes and their composite parts which was shown to the American Otological Society by Stacey Guild in 1936. Perhaps the most important channel is that of the tympanic membrane, the middle ear with its ossicles, its contained air, and the windows in its inner wall, though there is still some difference of opinion as to the share in the process of conduction taken by these various parts.

The tympanic membrane. The tympanic membrane is a very remarkable structure with its epithelial covering, its inner coating of mucous membrane, the inclusion of the handle of the malleus, the blood vessels and the elastic fibres in its intermediate structure. I have often felt that it has received neither the attention nor the publicity that it deserves. It must be an example of a perfectly elastic membrane and it has been shown experimentally that it can be set in vibration by sound waves of such minute intensity as 10^{-9} microwatts per square centimetre. When subjected to such a force at a frequency of 3,000 cycles per second it moves through a linear displacement which, according to Wilska, is only one hundred thousandth of the wavelength of green light and yet its movement is such a faithful reproduction of the sound wave that the appropriate acoustic sensation becomes apparent. Lindsay, Kobrak and Pearlman have been able to see the movements of the ossicles, by means of a low power oto-microscope, with a stroboscopic attachment, when the stimulating tone is 128 cycles and its intensity 75 decibels or more. Its movement is not merely a piston-like in and out movement, but is a lengthening and shortening of its conic arrangement. Macnaughton-Jones devised experiments to show, on a large scale, exactly what form these movements take, but the difficulty in reproducing the texture of the tympanic membrane is very great and the force used was so much greater than waves of sound, that the movements he described probably do not reproduce those of the living membrane. By means of small mirrors attached to the membrane it has been shown that the displacements of the drumhead are greater in an outward direction than in an inward one, probably in the neighbourhood of a 2-1 ratio.

The ossicles. The ossicles form a very important link in the sound-conducting chain. Their movement is restricted and modified by their attachment to the tympanic membrane, and to the membrana ovalis, by the tympano-malleolar ligaments and also by the intrinsic muscles of the middle ear. There is a certain stiffness in this chain of ossicles, and unless the amplitude becomes relatively great, and as long as the chain has an internal cohesion greater than the fixation of the stapes in the oval window, it moves in and out as one single mass. Greater amplitudes of excursion may cause some separation of the malleo-incudal joint and might result in "chattering" but this does not happen with the ordinary degree of movement. With the greater movements of the drumhead the excursion of the malleus outwards is greater than its excursion inwards in

a ratio of 2-1, there is a similar though smaller disparity in the movement of the incus, but the inward and outward displacement of the stapes are always symmetrical. The axis about which the malleus and incus rotate is roughly the line of the temporo-malleolar ligaments and movement only takes place about the axis. It has been calculated by von Békésy and Ernst Bárány that the vertical difference between this axis and the centre of gravity of the malleo-incudal mass is not more than one-hundredth of a centimetre and if this estimate is even approximately correct the chain must be extremely well balanced. Whilst the movements of the malleus and incus are solely in and out, when the responsible force consists of sound waves, that of the stapes is a rocking movement. This is achieved by the fact that the fibres of the membrana ovalis are shortest and strongest in the postero-inferior corner and are longest and thinnest in the antero-superior corner. The short postero-inferior fibres act as a hinge and the footpiece of the stapes rocks on this point. This is facilitated by the shape and direction of the lenticular process of the incus.

With considerable degrees of movement the excursion of the stapes is said to change to a rotation about the long axis of the footpiece, which imparts considerably less energy to the endolymph of the cochlea and therefore has a protective function, and it occurs at about that level of intensity where auditory sensation becomes one of pain.

The area of the tympanic membrane is 90 square mm. and that of the oval window is 3.2 square mm., but it seems unlikely that energy is increased by thirty times, and though the momentum of the stapes may be increased, the amplitude of its excursion, owing to the ossicular mechanics, is reduced to considerably less than that of the tympanic membrane. It has been suggested by Bárány that the ossicular chain is a clumsy apparatus for conducting air-borne sounds but that it has an additional function in reducing bone conducted sounds. He states that in the lower animals bone conduction plays a very small part in audition and as the scale of evolution is ascended the ossicular chain is developed to reduce, by its moment of inertia and by the fact of the axis of vibration and the centre of gravity being almost identical, the transference of bone-borne sounds.

Intratympanic muscles. While what has been said of the movements of the ossicles seems to be essentially true, their mechanics and movements are modified by the action of the two intratympanic muscles. It will be recollected that the tensor tympani takes origin from the walls of the muscular compartment of the Eustachian tube, is inserted into the neck of the malleus, and receives its innervation from the otic ganglion, whose afferent fibres come mainly from the third division of the Vth nerve, but fibres also join the ganglion from the VIIth nerve *viâ* the tympanic plexus and the small superficial petrosal nerve.

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The stapedius muscle arises inside its own bony compartment in the bone behind the tympanic cleft, is inserted into the neck of the stapes and receives its innervation directly from the VIIth cranial nerve. Byrne has investigated at some length the associated contraction of the orbicularis oculis and the stapedius. He states that this is so marked that strong voluntary contraction of the orbicularis oculis causes a drumming noise in the ears and that this is a combined protective contraction of both muscles. It is a personal experience that the noise can be so produced at will.

The tendons are contained in bony canals except for the very shortest interval before their insertion. Von Békésy considers that this is very fortunate, because if more of the tendons were fully exposed in the middle ear they might be caused to vibrate by transmitted sounds and unwelcome modification of the vibrations reaching the cochlea might occur. It has been assumed that the effect of contraction of the tensor tympani was to put the tympanic membrane in a state of tension and to close up any gap in the malleo-incudal joint, that is to put the drumhead and ossicles in the position of listening. The stapedius has the reputation of acting as a brake on the stapes and preventing undue excursions of its footplate into the oval window. This is confirmed by a series of experiments by Wiggers who has shown by means of mirrors attached to the tendons of the muscles that the stapedius responds better to tones up to 3,000 cycles per second but the stapedius and the tensor tympani react alike to tones above that limit. The degree of response of the muscles runs roughly parallel to the curve of audibility, but above 8,000 cycles it shows greater sensitivity. Wiggers also showed that artificial stimulation of the muscles caused a varying alteration in the electric output of the cochlea at different pitches. At 60 cycles there was a considerable diminution, at 1,000 the output was not changed, at 1,300 it was increased and at 2,000 it was unchanged. The marked reduction at 60 cycles suggests a damping or protective action of the muscles at this level and the increased sensitivity at the level of 1,300 cycles suggests a tuning-in effect of the muscles.

The damping down of the low tones has not only a protective effect but it also improves hearing at higher pitch levels. It is known that low tones mask high tones and that high tones only mask low ones to a lesser degree. The abolition therefore of a portion of the low tones will aid the perception of the higher ones. One tone tends to mask another one to a greater degree the nearer in pitch they are, until they approach near enough to produce beats, when the masking effect no longer exists. This may be summed up in the statement that contraction of the intratympanic muscles causes a shift of the frequency characteristic of the tympanic membrane and ossicles towards the upper end of the scale (Stevens and Davies).

Von Békésy said that it is difficult to explain why three ossicles, two muscles, two joints and a multitude of ligaments should be necess

to conduct sound to the cochlea. He considers that the function of all this apparatus must be protective, but as Ernst Bárány points out, the ears of birds and other animals have to survive with a columella only. Bárány is of opinion that the inertia of the ossicular chain has an effect in controlling the degree of sound passing through to the cochlea.

The windows. It has been assumed that sound waves are carried to the cochlea by the ossicles and the membrane of the oval window and that as the stapes was pressed inwards, the wave of increased pressure would force the membrane of the round window outwards, and that this was necessary to allow of variation of pressure in a closed cavity with inelastic walls.

Doubts have been cast on this sole channel of sound conduction across the middle ear and the suggestion of the aerocochlear route *via* the round window was put forward by A. Bonain and by Gustav Alexander of Vienna. Bonain argued from an evolutionary aspect that the first function of the otocyst was to preserve equilibrium and that the membrane protecting the otocyst is homologous with the oval membrane and the latter is therefore designed for equilibrium rather than hearing. The bony cover of the membrane is represented by the footpiece of the stapes. As the Eustachian tube and middle ear develop the round window is formed, giving direct access to the cochlea. In cetaceans where the cranial bones shut off the middle ear from the outside, the round window is enlarged to compensate for the greater obstruction to sound waves. Bonain considers that the oval window and ossicular chain are developed for the protection of labyrinthine structures and that the round window alone transmits sound.

Alexander did not go quite so far as this. He recognized an ossiculo-cochlear and an aero-cochlear route, utilizing the oval and round windows respectively. He stated that in those animals in which hearing is of more importance than sight, the tympanic bulla and the round window are more highly developed and this implies greater conduction by the round window. This is a marked phenomenon in cats. In certain vertebrates the ossicular chain is less well developed and in these the round window is relatively enlarged. Alexander was of opinion that sounds up to 90 cycles per second are conducted by the ossiculo-cochlear route but that the higher notes reach the cochlea by the round window.

Stevens and Davies consider that the oval window is the more important, and that the only function of the round membrane is to permit change of pressure or mass movement in the intracochlear fluids, by acting as a safety valve. At the same time they agree that where there has been very considerable loss of tympanic membrane and perhaps of ossicular tissue, hearing may remain very good and probably in this case sound traverses the round window. They quote the work of Hughson and Crowe who found that hearing was improved by the packing.

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with cotton wool, of the fossula rotunda and achieved the same results by grafting pieces of periosteum over the membrana rotunda. This is the opposite effect to that of granulation tissue covering the membrane. They suggest that this effect is produced, not by immobilizing the round membrane and preventing loss of energy as Hughson and Crowe suggested but by protecting the round window from the impact of air-borne sound waves in the middle ear. They point out that if the endolymph of the scala tympani is rigidly enclosed by fixation of the round window its movement is damped down and hearing must suffer. If, however, it is not rendered immobile, but merely protected, its function as a safety valve is facilitated and the acuity of hearing enhanced. Sound reaching the basilar membrane by the round window and scala tympani would be of opposite phase to that entering by the oval window and scala vestibuli.

Hallpike and Scott have occluded the round window of cats with plaster of paris and found no loss of electrical response to aural stimuli. They also examined the internal ears of a patient who had normal hearing but whose round window was almost completely occluded by new bone formation, the very small area not covered by bone being converted into thick fibrous membrane. The patient was not tested above 4,096 cycles but heard normally below that pitch. This is in opposition to the views of Alexander and Bonain and while the matter is still open to further experimentation the recent views expressed by Stevens and Davies seem to be the more easily accepted.

Bone conduction The pathway by which sound waves are conducted through the middle ear to the cochlea have been considered and it is now appropriate to discuss the conduction of sound vibrations through the skull. In Guild's schema the course of sound applied to the head is by the skin and other soft tissues of the scalp, the skull bone immediately beneath this area of skin, other skull bones and finally the petrous bone itself.

The scalp behaves as an elastic viscous medium and has an effect on the conduction of vibration to the skull. Von Békésy and Barany have examined this effect and have calculated its amount. In accurate quantitative audiometry its effect is not negligible and Barany has made a series of tuned bone conduction applicators in which correction is made for this amount of variation. They have to be applied with a certain definite force, and one applicator is only accurate for one particular pitch or its near vicinity.

The bones of the skull play an important part in the conduction of sound to the endolymph. The skull as a whole may indulge in translatory and in rotatory movements and energy may be conducted directly through the skull bone to the petrous pyramid, or it may cause resonance in the skull, including the paranasal sinuses. The translatory movements take place most readily from side to side and are limited by the inertia of the skull and by the stiffness of the neck and the attachment of the

skull to the vertebral column. The rotatory movements, about the occipito-atlantal joint, depend on the site of application and the direction of the force applied.

Bárány extending von Békésy's experiments believes that energy is conducted from the bones of the skull to the ossicles and that the energy from the translatory movements of the skull is partially neutralized by the inertia of the ossicles. But for this mechanism, which is poorly adapted for air conduction but ideal for damping down bone conducted sound, the amount of bone conduction would be much greater. The inertia of the ossicles provides the protective function for low tones, but for high tones it assists rather than hinders the transmission of sound. The movement of the ossicles resulting from the rotatory movement of the skull is not cancelled out by inertia and varies with the magnitude of the energy supplied. The reason why the bone conducted sound is loudest when the stem of a tuning fork or of a bone conduction receiver is applied to the mastoid process is that a greater degree of energy can be imparted to the ossicular chain from this point and its inertia overcome to a greater extent. It is believed that the brain does not have any measurable influence on bone conduction but remains inert in its water casing.

Guild on the other hand believes that energy is conducted directly to the internal ear by trabeculae of bone and considers that the most important trabeculae are those which lie immediately below the aditus—the sub-aditus trabeculae. The distance of this bridge is from 2 to 6 millimetres. Guild was able to examine the petrous bones of a number of individuals who had good hearing by air conduction but whose hearing of bone conducted sound was much reduced. He found in these cases that practically all the trabeculae were broken with little or no formation of callus. In severe cases all the trabeculae were fractured. Confirmation of this hypothesis is shown by the experiment of listening through a stethoscope to the forehead of a patient with bone conduction deafness when a sound not heard by such a patient by bone conduction could be heard by an observer through the stethoscope or could be heard by the patient by air conduction.

Guild also found that hearing by bone conduction for sounds of 256 or 512 cycles was not impaired by removal of the lenticular process of the incus, but for sounds of 1,024 and 2,048 the hearing is impaired. Such a lesion greatly raises the threshold for air conduction at all frequencies. He therefore considers that bone conduction is very largely osseous and not osseotympanic.

Macfarlane, who says that the story of bone conduction is an otologic saga told in pieces from the remote past but never presented in one free flowing story, considers that the resonance of the skull is of some importance in bone conduction. He says that resonance of the skull is influenced

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by asymmetry of the skull—which is present to some degree in all cases, by the density of bone, and by the condition of the paranasal sinuses. Asymmetry of resonance may be responsible for the many anomalous results of the Weber lateralization test. In some cases the sound is lateralized to the good ear in transmission deafness. In the Weber-Schwabach paradox of McKenzie a fork is heard louder by bone conduction than by air on the side affected by mastoiditis, but when applied to the vertex is referred to the healthy side. The lateralization also may vary with the pitch of the fork used. Resonance probably explains the fact that a fork applied to the parietal eminence is heard in the opposite ear. Changes in the bone itself do not appear to alter resonance to any great degree, but the condition of the paranasal sinuses does have a considerable effect, though sometimes in the opposite direction to which it might be expected. Resonance reinforces sound but also uses up acoustic energy and causes a shortening of the period during which a fork might be heard.

Resonance of the skull is responsible for the phenomenon that when a sound of 50 or more decibels is sounded one metre from the head, the same sound at the same loudness can be picked from the skull by a stethoscope or contact microphone. Perception of sound in the ear opposite to the mastoid process to which the stem of a tuning fork is applied may be of considerable amount and may be due to the resonance of the skull. This facility for transmission across the skull explains the ease with which a false interpretation of Rinne's test may be obtained. It is this phenomenon which makes masking of one ear necessary while testing for thresholds in the other ear.

Sounds reaching the cochlea by air conduction and by bone conduction cause a similar movement of the endolymph fluid and of the basilar membrane. The bone conducted sounds are carried to the cochlea by vibration of the skull bones, which vibrations cause compression of the canals of the internal ear. The effect of this compression is more marked in the case of the scala vestibuli than in that of the scala tympani because the oval window with the stapes is less elastic than the round window, and therefore pressure mounts more quickly. In addition to this the semi-circular canals communicate with the scala vestibuli and when they are compressed by skull vibrations fluid is forced into the scala vestibuli. If the internal ear was symmetrically compressed and if the oval and round windows were equally elastic they would bulge to an equal amount and the basilar membrane would be undisturbed, but as the round membrane can bulge to a greater extent and more quickly than the oval, the basilar membrane is pushed towards the round window. When fluid is forced in from the semi-circular canals the pressure in the scala vestibuli is increased and the basilar membrane is further displaced (Stevens and Davies). Von Békésy has confirmed this by experiments in which bone

electric potential, they are for a certain time exhausted and require a period of rest before repeating the process.

Localization. Sound does not travel in straight lines but can flow round an object, and it does not form definite shadows. The ears do, however, contrive to localize the source of sound and under certain circumstances to estimate its distance. This power of localization is due to the ability to note differences, in the two ears, of intensity, of phase or of time of arrival of sound. A considerable amount of research has been carried out on the reaction to these three differences and recourse has been had to dichotic stimulation—leading sounds of different intensity, differing phase or different time of arrival to the two ears, and noting the apparent localization of the source of sound.

Intensity. Pure tones of similar frequency but relatively varying intensity are led to the two ears and the sound is localized to the side of greater intensity. When an actual source of sound lies to the side of the head, the intensity of sound reaching the nearer ear is greater than that reaching the further ear, partly because it has a shorter distance to travel and also because the further ear is in the sound shadow of the head. The shadow is very slight in the case of low frequencies but with the higher notes there is a considerable difference from this cause.

By dichotic stimulation there is a high degree of accuracy in localization as to right and left, especially as the difference of intensity increases. Most observers find, however, that, after deviation from the mid-line has been established, there is difficulty in deciding whether a sound lies in front of or behind the ear. The stimuli from a sound located, say, 30 degrees in front of the interaural plane and one 30 degrees behind it are very similar and it is difficult to decide from a single stimulus from which position it came. Testing with a constant source of sound in different positions shows that sound coming from behind the ear is less well heard than that coming from in front. The sound shadow cast by the external ear is considered to account for this.

Phase. Two sounds differing only in phase and led to the two ears give rise to localization to the side of the more advanced phase. When a sound wave approaches the head, the crest of a particular wave reaches the nearer ear and by the time it arrives at the further ear, a different part of the wave cycle has been reached and there is a difference in phase. This causes a localization of sound to the side of the nearer ear and it is confirmed by artificially leading sounds of different phase to the two ears. Localization is then referred to the side of the advanced phase. If, however, the phase difference is more than 180 degrees the second ear is really at the level of the more advanced phase and sound is localized to the side of the second ear. The phase difference becomes more than 180 degrees when the distance between the two ears is less than half the wave length and this condition comes into operation at a frequency of

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about 800 cycles per second. Below this level differences of phase serve to localize the origin of sound.

Time of arrival. The relative time of arrival, at the two ears, of waves of a continuous sound do not give a clue to its localization, except as described in its relation to phase. A short sharp stimulus such as a click acts differently and the source of sound is referred to the side at which the sound of a click is first heard. This applies equally to whether the click actually occurs to one side of the head or whether the clicks are led independently to the two ears with a small time interval. There is a minimal amount of time interval below which no localization occurs and another greater gap above which there appear to be two separate clicks and there is no localization.

These are results of experiments which have been concerned with the head in a fixed position and a source of sound variable in its attributes of intensity, phase, time and position. This is a matter of necessity if the mechanics of localization are to be understood. The procedure of localization in ordinary life is fortunately made easier by the ability to move the head, either in linear direction or by rotation. The head can be moved about until either the impressions received in the two ears are identical when the source of sound will be directly in front—or behind, or until the difference between the two stimuli is found to be maximal when the source of sound will lie along the interaural axis.

Distance. Distance of a source of sound from the observer can be estimated from its intensity if the sound is a familiar one, but with an unfamiliar one this is rarely possible. A certain amount of assistance may be found in a trained observer by comparing phase with the azimuth, but in untrained observers direction may be accurately foretold but distance can rarely be estimated.

And now you have heard "great argument about it and about", and I would close by repeating to you a very concise summary of the physiology of hearing by an English physician who turned poet and became Poet Laureate. Dr. Robert Bridges wrote in his "Testament of Beauty":

"Hast thou then thought that all this ravishing music
is but a light disturbance of the atoms of air,
whose jostling ripples, gathered within thine ear, are tuned
to resonant scale, and thence by the enthroned mind received
on the spiral stairway of her audience chamber . . .
and that without thine ear, sound would hav no report,
Nature hav no music."

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But nerve fibres cannot conduct impulses without producing potential changes and therefore the auditory nerve fibres are bound to show electrical effects of their own whenever they transmit messages to the brain. These true nerve potentials will not have much effect on an exploring circuit unless one of the leads is close to the nerve, but it has to be recognized that potential changes in the neighbourhood of the cochlea may have a double origin. They may be due (*a*) to the cochlear structures and (*b*) to the auditory nerve fibres. When the lead is from the round window the potentials will be almost entirely due to the cochlear effect; when it is from the auditory nerve or auditory tract in the brain stem the potentials will be mainly due to impulses in nerve fibres. For the disentangling of this double electrical effect in the auditory mechanism we have chiefly to thank Hallowell Davis (1934) and his colleagues in the Harvard Medical School.

The most definite advance has come recently from the investigation of the nerve component. The technique has now reached the stage at which it is possible to record the messages in the individual nerve fibres and we can form a clear picture of the way in which the pitch and the intensity of a sound is signalled to the brain. But before we come to this it will be necessary to review what is known about the cochlear effect and what we may expect to learn from it.

The cochlear potentials, amplified and turned back into sound, give a very good reproduction of the sound waves which have fallen on the ear. They show, therefore, that there is a structure in the inner ear which reacts faithfully to air vibrations over the audible frequency range. The next step is to determine for each sound frequency the minimum intensity needed to produce a detectable electric effect at the round window: when this is done it is found that the electric audiogram, the curve relating frequency and threshold for the cochlear effect, in a cat is a very close copy of the curve relating frequency and threshold for hearing in man.

This agreement gives us no right to assume that the threshold or the magnitude of the cochlear effect and the acuity of hearing will always run parallel—one of the earliest findings was that the cochlear potentials would persist although the auditory nerve had been damaged in a way which would certainly cause deafness (Adrian, 1931). But no condition is known in which there is a failure of the cochlear effect and a preservation of hearing. It is fairly clear, therefore, that the structures responsible for the cochlear effect are closely concerned in the receptor mechanism of the inner ear and it would be reasonable to expect that any marked alteration in the cochlear potentials would mean a similar alteration in the acuity of hearing.

This gives the cochlear effect a certain practical importance, for it offers a means of testing the result of operations, etc., using an anæsthetized

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animal instead of man—for instance, one can easily study the effect of incising the ear drum, destroying the ossicles, etc. But it must be admitted that the cochlear effect has come rather too late in the day to be a guide of much value, for the effects of most of these procedures was known already, and almost the only practical outcome is Hughson and Crowe's attempt (1932) to improve hearing by plugging the round window. If it could be detected in man the cochlear effect might become a valuable aid to diagnosis, but unfortunately the places where it reaches high intensity are inaccessible without operation.

So far, then, the practical value of the cochlear effect has not been great, though it may become so in future. And its importance for the theory of hearing has been limited by the uncertainty as to its origin, for until recently it was not known whether the potentials were derived from the organ of Corti or from some of the membranes and fluids in the inner ear, or whether potential oscillations of different frequency came from the same or from different parts of the cochlear structure.

In the last two years, however, much of this doubt has been resolved by the work of Walzl and Bordley (1941) at Johns Hopkins. They have devised a method of producing localized injury to the organ of Corti and they have found that the result is a failure of the cochlear response to sounds of a limited range of frequency. Injury near the base of the cochlea raises the threshold for high notes and near the apex for low. Their curves showing this selective impairment leave no doubt that the cochlear potentials are due to structures which are tuned to particular frequencies and are localized to particular parts of the cochlea. In this they support the conclusion which was reached some years before by Hallpike and Rawdon-Smith (1934) on evidence which they afterwards judged insufficient. And further work of Walzl's makes it highly probable that the structures which produce the cochlear potentials are the cells of the organ of Corti, tuned to particular frequencies because they are attached to the fibres of the basilar membrane.

In their work on the effects of localized destruction of the receptors Walzl and Bordley found that there was never a complete failure of the electric response for particular tones. For a certain narrow frequency range the threshold is greatly raised, but a tone 20 or 30 decibels louder than the normal threshold intensity will still produce a response. The simplest explanation is that a loud note affects the basilar membrane over a large area though the peak effect is sharply localized.

These results alone would be strong evidence for some form of the resonance hypothesis and they lead us directly to the other component of the electric response, that due to the action potentials of the auditory nerve fibres. The evidence from the nerve action potentials is now quite clear and is in complete agreement with the evidence from the cochlear potentials. The earlier work was not conclusive. It revealed true

action potentials in the auditory nerve fibres and in the tracts in the brain stem, but there was little to show how the messages in the nerve were organized. It was not possible to distinguish what was happening in each nerve fibre and therefore not possible to say how the pitch and intensity of a sound was signalled to the brain. The one thing which stood out clearly was that the impulses in the nerve fibres had a fairly close phase relationship with the sound waves so that the composite potential oscillation in the auditory tract reproduced most of the sound frequencies, though it did so far less faithfully than the cochlear response.

The evidence has now been greatly extended by Galambos and Hallowell Davis (1942). They have succeeded in recording the impulses in single fibres of the auditory nerve by using a glass micro-electrode thrust into the nerve trunk. I was fortunate in seeing some of this work when I visited Dr. Davis at Harvard last January. The nerve was reached through a hole in the temporal bone so that there was no mechanical damage or interference with the blood supply to the inner ear, and the electrode was adjusted by a micro-manipulator until one series of impulses stood out clearly in the record. The results are unexpectedly simple. The messages in the fibres of the auditory nerve turn out to be organized in the same way as in all the other sensory nerves. The frequency of the impulses varies with the intensity of the excitation: there is often a resting discharge at a low frequency and when the stimulating tone is sounded the impulse frequency rises to an initial maximum and then falls to a lower level which declines very slowly as long as the stimulus is maintained. And finally the receptors of each nerve fibre are specially sensitive to sounds of certain pitch though they can be stimulated by louder sounds of slightly different pitch.

Thus the records from single fibres of the auditory nerve are indistinguishable from those of fibres leading from stretch receptors in muscle, pressure receptors, etc. They are equally indistinguishable from records from single fibres of the vestibular part of the VIIIth nerve, for here, too, there is the usual rise and fall in the frequency of the impulses in agreement with the intensity of the stimulus.

Galambos's curves show that the frequency of the impulses in single fibres rises from zero to a maximum of about 400 per sec. when the sound is increased to about 30 decibels above the threshold intensity. This range of impulse frequency is the same whatever the pitch of the stimulating tone. But if the frequency of the nerve fibre discharge is governed by the intensity and not the frequency of the stimulus, how comes it that the composite response of the auditory tract reproduces the sound frequency, as it certainly does to some extent? The answer is that for each fibre the impulses arise in phase with a definite part of the stimulating wave cycle, though the number of impulses may be a small fraction of the

Electrical Reactions of the Cochlea

number of sound waves which set them up. Now there is no reason why the impulses in different nerve fibres should always be set up by the same wave cycle. Thus owing to the rigid phase relationship between stimulus and response, a number of fibres might give a composite potential oscillation showing the frequency of the stimulus, although each fibre gave only a submultiple of that frequency.

Finally we come to the way in which the pitch of the note is signalled, to the brain. It is found that each nerve fibre, or rather each group of receptors connected with one nerve fibre is most sensitive to a particular frequency, but can be stimulated by louder notes over a wider frequency band. At levels of 100 decibels or more above threshold notes with a frequency as far away as 3 octaves below and $\frac{1}{2}$ octave above may be adequate. In fact the nerve results agree completely with Walzl's cochlear results in supporting a resonance hypothesis which differs little if at all from that of Helmholtz.

According to this view pitch depends on what part of and intensity on how much of the basilar membrane is disturbed by the sound. To signal a complex sound the composite message which reaches the brain must reproduce the rapidly changing pattern of excitation in the basilar membrane with all its peaks and troughs. This is made possible by the fact that the arrangement of the auditory nerve fibres is preserved all the way up to the receiving area in the cerebral cortex. In the cat the auditory area is in the ectosylvian gyrus and can be readily mapped out by the electrical signs of activity which occur in it when a note is sounded (Bremer, 1938). Woolsey and Walzl (1941) have tried the effect of stimulating the nerve fibres supplying different parts of the basilar membrane and have shown that the anterior part of the cortical auditory area is connected with the basal turns of the cochlea and the posterior with the apical. High-pitched notes will therefore cause activity further forward in the auditory region and low pitched further back. Again the arrangement of the auditory system is on the same fundamental plan as that of other sensory systems. The changing patterns of activity in the striate area reproduce the play of light and shade on the retina just as those in the auditory area reproduce the peaks of vibration of the basilar membrane.

It is natural to ask what next? We have somehow learnt to react appropriately to these brain patterns cast by sounds and sights (and it is probable that we recognize smells in the same way by the pattern they throw on the olfactory area). More remarkable still, these patterns of brain activity make us see and hear, that is they produce mental as well as physical effects. How this is done is scarcely a problem for otology. It is certainly a problem which we must be content to leave unsettled, for although the auditory messages can now be traced some way into the brain, it must be admitted that we cannot yet trace them into the mind.

E. D. Adrian

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THE PROVOCATIVE TEST—A MITIGATED NUMBING TEST BASED ON THE SUSCEPTIBILITY OR VULNERABILITY TO NOISE

By F. KOBRAK (London)

THE effective Therapy of Hereditary Deafness is problematic. Cogently the question of preventing hereditary deafness is in the forefront, how to detect latent cases in families with taint of hereditary deafness, or to detect the earliest stages of defective hearing. Neither the routine audiometric tests, nor special combined tests of Audiometry and Tuning Forks (1940) were of any use in diagnosing early cases.

Afterwards an attempt was made to expose the normal ear to excessively loud sounds aimed at seeing if definite differences could be established between normal and hereditary cases. The first series of

Experiments on Numbing

was made in the autumn 1940, the second one in the winter 1940-41. Peyser's (1940) experiments only came later to our knowledge. At first we took the same line as Peyser did. The normal ear was exposed to Audiometer tones of the highest intensity over a period of one to three minutes. The highest intensity produced by the Western Electric Audiometer 2 B E is on 1024 v.d. But even this stimulus of 110 decibels was followed by a small impairment only of hearing. The figures were not so definite as to be taken as standard values of "fatigue" comparable with hereditary latent cases. Peyser who used only 80 decibels as Numbing stimulus could not produce any definite results either. In spite of this failure the research on the matter was not given up by us for certain physiological considerations especially on the factor of "fatigue".

Gradually increasing Damping effect against gradually increasing sound intensities comes into operation in animals (1930). In order to imitate animal experimentation the normal ear was exposed to sound stimulation of intensity higher than that available by strongest audiometric stimulation. Edelmann's Tuning Fork c4 out of the "Continual Set of Tones" was used as shock stimulus instrument. The question was: What Damping effect, if any, is noticeable in the normal ear?

The procedure, as briefly reported (1942), is to hammer the fork repeatedly close to the ear. After 20 or 25 seconds a sensation of giddiness-pressure arises. Simultaneously, or shortly after, by continuing the hammer blows, a feeling of "cotton in the ear" appears, which was not, or only slightly noticeable with the audiometric 110 decibels stimulus. This feeling of definite tension in the ear was suspected to be

*a Muscular tension. It lasted often for 10 or 15 minutes, but sometimes only disappeared entirely after two or three hours.

The main points of the findings in Numbing experiments are as follows: most Numbing is caused round c5 by shock stimuli with Edelmann's Tuning fork c4. No outstanding pitch specific Numbing with c4 occurs.

Apart from real simple Numbing in the sense of a circumscribed lesion in the Corti organ, according to experiments on animals by Wittmaack, Marx and others, the following conditions are noteworthy: Bone Conduction figures pointed to a Numbing effect not quite analogous to those of Air Conduction. Besides the Cochlear Numbing effect a second Extracochlear Numbing effect seems to come into operation with "Bone Conduction". This extracochlear Numbing effect, which improves to some degree the figures of hearing tests in the Middle Ear for "Bone Conduction" relatively to Air Conduction, must be a Physiological Middle Ear Factor of Hearing, owing to its transience. It is suggestive that the more or less definite Extracochlear Numbing effect is nothing other than the Damping in the Tympanic Muscles.

This leads to an aspect of some practical significance: certain Numbing effects, which occur in daily life, e.g. as accidents, might be regarded from the point of view of a more complex phenomenon of hearing; not only should Intracochlear passive numbing be considered, but also Extracochlear Active Numbing, suspected to be associated with extraordinary Damping in the Tympanic Muscles, or even with concussion in the Tympanic Muscles, together with concussion in other parts of the Middle Ear.

These fairly trying Numbing tests were, of course, not suitable to be used with "good" hearing members of hereditarily suspected families, who were the original object of our research work. On the other hand, we had, unfortunately, no chance of testing members of noisy professions, where the objection of discomfort caused by the test could more easily be dropped.

Furthermore, apart from the interest in the physiology of the tympanic muscles' activities, the question of Numbing as a whole seemed to be worth while following-up, for a practical reason. Our daily-life hearing is, as a matter of fact, different from the ideal conditions in the otologist's silent room. Every noise or tone of speech or music and so on produces not only a specifically sensory effect, but also a purely stimulant irritating effect. Consequently, the question of studying the effect of controllable noise intensities on normal and abnormal hearing in the silent room arose. These mitigated Numbing tests are called

Provocative Tests

A Bárány Box of a pattern which covers the pinna, was used. The box produces, when fully wound up, a noise of fairly equal intensity.

The Provocative Test

The Bárány Box not only practically eliminates the hearing on the side of the Box, but affects also, what should not be overlooked, the opposite side. The rate of loss of hearing on the opposite side was studied, and further the question, what laws, if any, could be detected in these losses of hearing.

The procedure of the Provocative Test is as follows. Hearing tests are done without and with the Bárány Box on Air and Bone Conduction. The findings can easily be written down to get the Quantitative data of the test. The Qualitative aspect of the Provocative test can be drafted, as demonstrated below in Diagram 2, and can easily be illustrated on a pattern of a hearing curve.

An example of a Quantitative record on a Provocative test with normal hearing—Case No. 349 series of hearing tests—is shown in

DIAGRAM 1

	128	256	512	1024	2048	4096	
Figures of Air Conduction	23	19	20	17	12	12	without box
Figures of Air Conduction	51	55	55	54	43	38	with box
<hr/>							
DIFFERENTIAL FIGURES of Air Conduction	-28	-36	-35	-37	-31	-26	= sum -193
	128	256	512	1024	2048	4096	
Figures of Bone Conduct	18	16	15	31	19	8	without box
Figures of Bone Conduct	25	30	35	48	38	41	with box
<hr/>							
DIFFERENTIAL FIGURES of Bone Conduction	-7	-14	-20	-17	-19	-23	= sum -100

The Differential Figures of both Air and Bone Conduction are summed up and divided through the number of pitches tested. In our case the sum of Air Conduction figures amounts to 193, of Bone Conduction figures to 100. Divided through 6, the number of pitches tested, the Average Differential Figure of Air Conduction is 32, of Bone Conduction is less than 17. This relation between the two Average Differential Figures provides a value, which according to Rinne's nomenclature, for its "positive" or "negative" quality, may be called the "Provocative Rinne". In our case the

$$\text{Provocative Rinne is } \frac{\text{Bone } 17}{\text{Air } 32} = -15$$

There are certain differences in the Differential Figures of Air Conduction alone, easily demonstrable when drafted in a curve. These

figures, differential without and with box, are somewhat suggestive of special types of hearing of Middle Ear or Internal Ear deafness. However much more informative and characteristic indeed are the relations between Bone and Air Conduction, the Provocative Rinne figures.

The Qualitative Provocative Rinne

Our experiences on the Provocative Rinne cover some 150 cases tested at University College Hospital, since September 1941.

Amongst Qualitative differences in the Provocative Rinne tests of the interrelation between high and low pitches, the typical Crossing of the Bone and Air Curves of the Differential Figures is an outstanding feature. Normally the Crossing point lies between 2048 and 4096, *vide* Diagram 2 A., or less frequently between 1024 and 2048. The Shifting of the Crossing point to the left up to or beyond 512 is highly suggestive of Middle Ear alterations (*vide* Diagram 2 B.) Sometimes it happens that the Crossing point is at the correct place, between 2048 and 4096. But whereas in normal cases, the major, left part of the curve of the Differential Figures is Rinne negative and the small, right part is Rinne positive, there are cases, in which this relation between right and left is reverse, that means just a negative Provocative Rinne with the right part and a positive Provocative Rinne with the majority of the Differential figures left. These are Middle Ear cases suggestive of some cochlear lesion.

An example will demonstrate how far the Shifting of the Crossing Point to the left can be useful, when otherwise no diagnosis could be made.

The first case (Diagram 2 A.) has a "Normal" hearing, the second case (No. 270) (Diagram 2 B.) refers to a doctor, who had definite difficulty in hearing with the right ear for five weeks after sinus trouble. Otoscopic and routine hearing tests were normal. There was no improvement after inflation.

The Rinne figures are given from left to right, from 64 up to 8192 decibels.

DIAGRAM 2

	64	128	256	512	1024	2048	4096	8192
A. Normal case								
Provocative Rinne	-17	-22	-7	-9	-17	-5	× normal crossing	+7 +23
B. Doctor's case								
Provocative Rinne	-25	-12	-11	× crossing shifted to the Left	± 0	+6 +6	-2	+7

This case is suggestive of an inefficiency in the middle ear, possibly in the tympanic muscles.

The Provocative Test

The Quantitative Provocative Rinne

The interpretation of the Quantitative Provocative Rinne Test is simpler and sufficient with the majority of cases. Four main types of response can be stated upon the Quantitative Provocative Rinne.

(1) "NORMAL" TYPE

The Provocative Rinne is negative within a rather wide range, from the lower limit of 3 to 5 decibels up to the upper limit of 15 to 30 decibels. The Bone Conduction Curve is, in general, well above the Air Conduction Curve, except the figures right of the Crossing point. The width of range seems to be associated not alone with the sensitivity of the sensory organ, but also with the sensitivity of the vegetative nervous system, with the individual response to reflexes, in general. The definite negative Provocative Rinne is in concordance with the less marked negative Rinne, mentioned above, on Numbing of highest intensity.

May be, the normal response to noise of small and medium intensity, increasing according to animal experimentation with growing intensity of noise, becomes less efficient—partly owing to lag in Damping?, when the ear is exposed to excessively noisy shocks, as in our Numbing experiments. This might give an explanation why the Rinne figures in our Numbing tests were, though noticeable, much smaller than those often obtained with the mitigated numbing in the Provocative Tests, which is more adapted to the conditions of daily-life hearing.

(2) MIDDLE EAR TYPE

The Provocative Rinne is more or less positive, just in contrast to the Routine Rinne test. The Bone Conduction Curve is, in general, well below the Air Conduction Curve. Positive Provocative Rinne of +1 decibel is of course highly suggestive, a Provocative Rinne of, say, +5 decibels proves the presence of a Middle Ear type. Figures of slightly negative Provocative Rinne tests, approaching nearly the zero line, are the more suggestive of a Middle Ear type, when the Crossing point in the Qualitative test is shifted to the left (*vide* Diagram 2).

Routine audiograms are not rarely inconsistent, whether a Middle Ear or Internal Ear deafness is dealt with. The Provocative Rinne is often a good diagnostic help, especially in cases of combined Middle Ear and Internal Ear deafness. This might be illustrated by the following cases Case No. 383, male patient, 31 years. Right ear typical advanced otosclerosis. Left ear: Routine Audiogram not yet typical difference between low and high pitches. Both Bone and Air Conduction Curves of the left ear are inconclusive. With Edelman's tuning forks the Routine Rinne tests are definitely positive, the Schwabach tests definitely negative. This is, obviously, a case of cochlear type of defective hearing in the left "good" ear with "one-sided" otosclerosis in the right ear. The

to have a Middle-Ear or Non-Middle-Ear sign as a whole independent of the locus of the lesion in the cochlea or in the path of the cochlear nerve. This is provided to some degree in the original Rinne test and seems to be further elucidated with the Provocative tests.

The Provocative test should not and could not be a Routine Audiometer test. But it might play its part.

(1) In checking certain cases of differential diagnostic significance.

(2) Possibly in detecting early cases of latent deafness, especially in hereditary families.

(3) In discriminating candidates for noisy professions, whether they are normally susceptible or abnormally vulnerable to noise.

It is suggested that item (3) especially might be followed up by otologists, who encounter candidates for noisy professions or occupations.

Unfortunately, the Provocative test needs much more time than the Routine Audiometry. For the sake of safety each figure was checked, and repeatedly checked, when the difference between first test and control test was more than ca 6 decibels. The control test should never follow immediately the first test on one and the same pitch, that means not without the interpolation of another pitch.

Summary

A new audiometric test originating from experimentation on Numbing is described, the Provocative test.

The test is based on the response of hearing to a controlled intensity of noise, which is produced by a Bárány Box.

Different types of Provocative Tests are discussed. The Provocative tests reveal especially more details on the Middle-Ear function and on Middle-Ear deafness than the Routine Audiometer tests do. The Provocative Rinne test provides a completion and check of the original Rinne test.

The Provocative test seems to illustrate the response of the Middle Ear or Internal Ear as a whole. The test seems to be more independent of the place in the cochlea affected.

A theory of the Provocative test is given. A relation of the test to the Damping effect in the tympanic muscles is explained.

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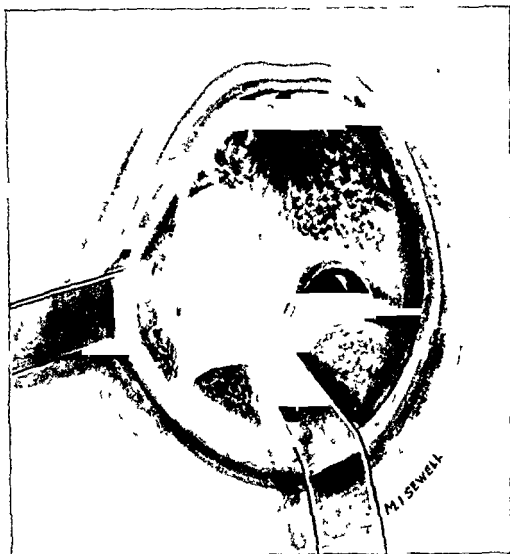


FIG 1

CLINICAL RECORD

MALIGNANT MELANOMA OF TONSIL AND FAUCES

By WALTER HOWARTH (London).

Miss B was sent to me by Mr Sheridan, of Truro, in August 1941, with the history that he had first seen her with diffuse and rather extensive pigmentation of the fauces and palate in May 1938, but that there were then no ulcerated or raised areas. He kept her under close observation and the condition remained practically unaltered for nearly two years and it was not until January 1941 that the raised, lobulated plaque began to appear.

As the condition was so widespread and as the area of pigmentation was so extensive and scattered, I hoped that deep X-ray therapy might get rid of it, but a full and intensive course had very little effect upon it, though the pigmentation certainly seemed a little lighter particularly in the hard palate. As will be seen from the drawing the main mass occupies the region of the tonsil. This raised plaque was hard and rubbery to the touch. There did not seem to be much local infiltration.

It was decided to excise the main mass as widely as possible and this I did with the diathermic knife. A year later the tiny spot in the left tonsillar fossa, which from the outset seemed a more intense jet black than the general pigmentation elsewhere, began to grow, so that this was excised with the diathermic knife.

It is, of course, too early to predict the ultimate issue but at the moment both tonsillar regions are well scarred whilst the diffuse pigmentation of the palate remains substantially the same. The patient has no pain or discomfort.

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

November 6th, 1942

President—F. C. ORMEROD, F.R.C.S.

Discussion on the Prevention of Chronic Otitis and Deafness

MR. W. STIRK ADAMS

THE title of this discussion has very wide implications, and I have taken it to mean the prevention, not only of the active infection which has resulted in chronic suppuration, but of all chronic otitis, whether the condition leaves a deaf ear or not, and of healed chronic otitis resulting in a deaf ear.

In defining deafness much more is implied than social deafness, and our aim in the prevention of deafness should be the prevention of all deafness resulting from otitis media.

In considering the otological approach to this problem it is encouraging to remember that it is only fifty-six years since the interest of surgeons and otologists brought this disease under surgical control.

In his *Diseases of the Ear*, Joseph Toynbee (1860), writing of perforation of the mastoid process, says: "I have never performed this operation, but I should not scruple to do so in a case where the life of a patient was threatened." During the succeeding years this approach was unaltered and McEwen (1893) tells us that he regarded 1886 as the date at which adequate reports on otological surgery began to appear.

At that time surgery was directed to the treatment of complications and the professional attitude to the disease was that of saving life. In the twentieth century much greater attention was directed to the hearing capacity of the individual after operation and the thesis of the preventive approach to mastoid surgery was first enunciated.

Since 1920 the necessity for earlier operation to prevent the development of a chronic ear has been accepted by otologists but I do not think it is fully appreciated by the medical profession how great an effort has been made by otologists appointed to Children's Hospitals. The number of preventive operations runs into hundreds a year in some of the Children's Hospitals, and in the pre-Sulphonamide era colleagues in Glasgow have told me they have performed as many as five mastoid explorations in one evening, and my colleague, Douglas Marsh, at the Children's Hospital in Birmingham, has told me he has also operated on five at one session: my own record is four.

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The introduction of Sulphapiridine has lessened the number of mastoid explorations required in Birmingham, but there has been no diminution in the number of patients suffering from acute otitis

Though the preventive approach to otitis media has been widely practised during the past twenty years there is still a high proportion of chronic suppurative otitis media in existence and I am able to supply four recent references bearing on this incidence

The most complete figures are those for recruit examinations in the American Army of 1918 (Britten, 1941), and cover nearly a million men. The average incidence of chronic suppurative otitis media per thousand drafted men in that year, throughout the country, was 6.81, and while this average was nearly true for many of the States variations between 15.14 per thousand in Rhode Island, with New York and Pennsylvania following closely, at one end of the scale, and Florida with 1.29 per thousand at the other. Again from America is a preliminary statistical report of volunteers in the Southern New York district of the Second Corps area (Leone, 1940)—June, July and August, 1940 ages 18-35—where in a total of 6,047 candidates, 32.5 per cent were rejected and of the rejects 10 per cent were due to failure to meet the hearing requirements. The majority of this group were found to be suffering from purulent otitis media in acute or chronic form in one or both ears associated with impaired hearing. While, again from America, in the examination of the National Guards pass reports (Haas, 1941), 7.2 per cent of chronic suppurative otitis media were found in 4,158 examinations in November 1941, while ear defects, including deafness here constituted 15 per cent of total rejections.

In this country, in reporting the first thousand cases which attended the Ear, Nose and Throat Department in a Military Hospital in 1941, Major D. H. Craig (1941) states that of these 243 were of chronic suppurative otitis media, and reflecting on the value of recruiting statistics, he states that in many cases, though the patient had an obviously long-standing chronic ear no note of this fact was found on his medical history sheet, and he adds "It would seem that a routine examination of the drumheads on enlistment is not always made. It is likely that the incidence of chronic suppurating ears among the troops in the area is actually much higher than the actual figures relate—a melancholy reflection when one considers that efficient local treatment in the early stages of an acute otitis media would render the chronic ear non-existent."

If we add to these figures our own experience, we are driven to the conclusion that there is a very high proportion of chronic otitis media in existence which is developing year by year, and it is also clear that if this is so many individuals pass through an acute otitis into a chronic otitis without otological control. In this connection I think we should reflect on whether all chronic otitis is a result of an acute otitis, and experience tells me that this is not so. I feel however, that the vast majority of chronic ears have passed through an acute phase before they reached their chronic condition.

Chronic suppurative otitis media or its sequelae is found most often in those whom we regard as the hospital class, and while we know that an acute otitis can develop and pass into a chronic infection in an adult particularly in epidemic times, most adults obtain treatment for this condition. It is in

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children, however, that the largest numbers of acute middle-ear infections are found. In the Children's Hospital, Birmingham, for many years we have averaged between 600 and 700 new patients every year under treatment, and in one year (1939) the total was over 1,000.

From *January to October 1942*, 1,036 patients have applied to us for treatment for acute otitis media and of these 227, 21.5 per cent., were under the age of one year. The majority of these are treated as out-patients but in any case in which the response to treatment is unsatisfactory the child has been admitted to the wards. My thanks are due to the Board of Management at the Children's Hospital and to my colleagues on the Medical Staff for their co-operation. In the past year my Board has allocated one-sixth of the available accommodation, reduced as it is owing to the Hospital being in a target area, to the treatment of these cases.

Out of a total of 292 patients admitted to the in-patient department from *October 25th, 1941, to August 8th, 1942*, 210 were suffering from acute otitis media and of these 134, (64 per cent.), resolved on treatment by paracentesis where required and M & B 693, while (74, 36 per cent.), required a cortical operation. Two patients, both infants, died from intercurrent enteritis. All the survivors were discharged from hospital with a dry ear, and nearly all with an intact drumhead. To give some indication of the type of case in which these results are obtained, Table A shows the duration of the aural discharge prior to admission in twenty patients who were under treatment in the ward on *October 29th, 1942*.

TABLE A.—DURATION OF DISCHARGE BEFORE ADMISSION.

Days	1	1-5	5-7	7-10	10-14	14-21	21-25	25-30
No. of cases	2	4	5	1	3	1	2	2

But there is another aspect to this problem, and in the years 1937-1941, 47 children have had a radical or modified radical mastoid operation performed. The accompanying table shows the age of onset of the infection which terminated in a radical mastoid operation—in some cases many years later.

TABLE B.—AGE OF ONSET OF OTITIS IN 47 RADICAL AND MODIFIED RADICAL MASTOIDS.
CHILDREN'S HOSPITAL, BIRMINGHAM, 1937-41.

Age	0-1	2	3	4	5	6	7	8	9	10	11	12 or over
No. of cases	11	8	7	2	7	2	1	4	1	1	2	1

While these results are obtained in cases which reach the hospital for treatment, from our experience it is evident that a large number of acute infections pass into chronic infections without otological treatment. Two recent experiences illustrate this point. Some six weeks ago in my out-patient department I examined two children:

A boy 9 years old has a chronic suppurative otitis media with a large attic defect. His history is of a discharge of three years' standing which has continued without intermission. No advice has been sought as there has been no pain. Pressure has been brought to bear by the School Medical Service who have advised removal of adenoids, which has been refused by his father. As the father suffers from ear trouble himself, he is now willing to allow an operation on the child's ear.

The second case is that of a boy aged 6, whose ear began to discharge three years previously after pneumonia, and has continued to do so. Hydrogen peroxide has

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been used by his doctor. The child was brought to hospital independently by his mother because of her anxiety about his ear. A wide inferior destruction of his drumhead was present, a chronic discharging ear, and hearing was reduced to six inches distance for the whisper.

There are four important measures in the prevention of this condition.

First Adequate education of the medical practitioner in the handling of an acute otitis. I regard it as important to diagnose and treat correctly an acute ear as an acute appendix (and the acute ear is much the commoner). It is difficult to give a student an adequate knowledge of this subject unless he spends an internship in the acute otitic ward. It has been suggested that otolaryngology should be regarded as a post graduate subject, but if this view is accepted the recent graduate will have an inadequate knowledge of diagnosis and treatment of this condition when he meets it in practice. The regulations for qualification should require an internship in an acute otitic ward prior to graduation, and the inclusion of a written and practical examination in otology in the final examination.

Second The provision of sufficient in patient accommodation in acoustic centres for the treatment of acute otitis wherever required. It is a common experience with us that at the height of an epidemic it is sometimes difficult to obtain in patient accommodation for a classic mastoid in a child, and it is just at these times that any less urgent otitis is likely to pass into a chronic condition.

In this connection I would stress the urgent need for providing further accommodation for infants. One fifth of all acute otitis in children occurs under the age of one year, and in these infants the otitis is frequently a part of a general medical illness. A highly specialized barrier nursing is required, and the closest co operation with the Department of Internal Medicine must be maintained in treatment.

Third The provision of an adequate acoustic staff trained in the work. This applies not only to our profession, but to the profession of nursing also, where there is no Register or Diploma in Otolological Nursing. I suggest that such a Diploma and Register should be established.

Fourth The education of the public in the necessity for early treatment. During the last twenty years the Otolological Section of the School Medical Service in our larger cities has done fine work, and a similar service of the highest standard should become a general rule. The results according to the figures of Crooks quoted by Norvick (1940) show that the incidence of chronic otitis in 1934 in London school children had been reduced to 0.9 per cent, while in the adjacent county of Essex in the same year it was 4.8 per cent.

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MR. E. NAYLOR-STRONG

AN audiometric clinic was established in Birmingham two or three years before the war in which a large part of the juvenile population of the city schools was tested. They were tested twice with a gramophone audiometer, but these tests and investigations have unfortunately been discontinued since the outbreak of war.

I am indebted to Dr. Mitchell, the Schools Medical Officer of the Education Department of our city, for permission to use the figures obtained in the Audiometer Clinic which was partly under my jurisdiction. Three districts of Birmingham have been singled out as representative. The first and last were rather poor districts, heavily populated; but the middle district was of a rather better class, but still of the class attending the elementary schools.

All the scholars in the schools were tested (Table I), and from the poor district, so-called, out of 3,731 children tested, 221 failed, roughly 6 per cent. The sexes were about equal. In the second district, which was rather better class, out of 4,876 cases, 277 failed to pass, 5½ per cent. In the third district, out of 3,253 tested, 165 failed to pass, 5·1 per cent. It will therefore be seen that the number of children whose hearing is not good, attending the city schools, is high. These are all children between the ages of 5 and 14, and no doubt if we took the whole population, the figure would be higher. There does not seem to be very much difference in incidence of the disease between the very lowest class of children, and those a little more fortunate. I regret that I have no figures for the secondary schools, which would have been interesting.

TABLE I.—AUDIOMETRIC TESTS.

	Number of Children Tested (Tests 1 and 2)				All Children			
	Boys		Girls		Passed		Failed	
	Passed	Failed	One ear	Two ears	Passed	Failed	One ear	Two ears
Clinic District	1,718	96	56	40	1,792	125	86	39
Sheep Street	2,357	154	119	35	2,442	123	91	32
Yardley Green Road	1,703	85	66	19	1,385	80	63	17
Aston	5,778	335	241	94	5,419	328	240	88
	Number of Ears Tested (Tests 1 and 2)				All Ears			
	Boys' ears		Girls' ears		Passed		Failed	
	Passed	Failed	Passed	Failed	Passed	Failed	Passed	Failed
Clinic District	3,492	136	3,670	164	7,162	300		
Sheep Street	4,833	189	4,575	155	9,408	344		
Yardley Green Road	3,472	104	2,833	97	6,305	201		
Aston	11,797	429	11,078	416	22,875	845		
Hearing Acuity for All Ears by Groups								
	A (-3 to +6)		B (+9)		C (+12 to +18)		D (+21 to +30)	
Clinic District	7,162	51	158				91	
Sheep Street	9,408	67	156				121	
Yardley Green Road	6,305	26	101				74	
Aston	22,875	144	415				286	

The second section of the Table shows actually the number of ears, and gives an index of whether one or both ears are affected. Out of 23,720 ears, 845 were not up to normal standard of acuity, roughly 3·7 per cent. of all ears.

The third section gives the number of ears which are affected according to the loss of acuity in decibels. Column A shows that nearly 23,000 hear fairly well, i.e. -3 to +6 decibels, but that 845 had a greater or lesser degree of deafness, 286 were very deaf, 415 were sufficiently deaf to make education quite

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difficult, and 144 could hear with great difficulty. This is quite a large proportion.

When these children failed in their tests the parents were interviewed, and the children examined by the aural specialist, in this case myself. Each case in these series I have examined personally.

The second table is a diagnostic one. The headings under which these cases are classified are arbitrary, and I have chosen the 14 groups as wide, general classifications, sufficient for the analysis, and open to some criticism as to the nomenclature and perhaps pathology. The left-hand column shows the type of disease. The numbers down the right-hand side are the total numbers of children. If we take the largest groups we find that out of 1,019 children, 470, nearly one-half, are deafened from chronic suppurative otitis media, 316, just under one-third, had wax in their ears, which caused the greater part of their deafness, but when this was removed one-third of these still had remaining deafness.

TREATED EARS		TABLE II	UNTREATED EARS	
Infected ears—				
Attic disease	14		Attic disease	4
Subacute otitis media	17		Subacute otitis media	16
Ch suppurative otitis media	470		Ch suppurative otitis media	20
Chronic mastoid	46		Chronic mastoid	0
Mastoids, post op	19		Mastoid, post op	81
Healed otitis media	28		Healed otitis media	261
Polypi	36		Polypi	0
Non infected ears—				
Eustachian obstruction	5		Eustachian obstruction	31
Other causes	2		Other causes	0
Wax	316		Wax	0
Retracted drumheads	26		Retracted drumheads	295
Foreign bodies	10		Foreign bodies	0
Normal ears	4		Normal ears	109
Not diagnosed	26		Not diagnosed	64
	<hr/> 1,019			<hr/> 881

Chronic suppurative disease of the active type was by far the commonest cause of deafness, and with suppurative otitis media, the subacute type and the chronic attic disease, and definite chronic mastoids and polypi, accounts for over one-half of the total cases of deafness.

It would here be wise to explain the two groups, infected and non-infected. The term "non-infected" means in the main that no suppurative process has been observed in the ears, no visible scars were left, and no history obtained of suppuration. Of these cases there were 389 out of 1,019. Foreign bodies were few in number. Healed otitis media accounts for 28, healed mastoids for 19, polypi, which really can be classed as chronic suppurative otitis media, or mastoiditis, for 36. The classification "not diagnosed" mostly consisted of various types of inner ear deafness, or transitory cases which were temporarily deafened from some cause not ascertained at the time. There were 26 of these in 1,019 cases.

Over one-half of the cases of deafness here presented might be prevented by early and proper treatment, and these figures show that if the problem is attacked from the right angle, and at the right time, it is a most promising field of investigation and cure.

If we take the large untreated group of 295 cases out of 881, which are put under the heading "Retracted Drumheads", we see that it is a

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greater proportion in these cases than in the 26 out of the 1,019 treated. This means that in treated cases retracted drumheads are a comparative rarity compared with those in untreated children. The treated children have had all kinds of treatment, i.e. their tonsils, their adenoids, or concomitant disease, if present, have received attention. They have been out into the country, and have received the very best attention from their doctors who have worked in close co-operation. The net result is extremely good. It is a figure of 26 against 295. Some of these 295 retracted drumheads get better because the causes are transitory, and during second testing some months later 150 were very much improved, but if we assume the whole of these get better it still leaves 145 as against 26 in the treated group. This shows clearly the necessity for general treatment in addition to local treatment, and the efficacy of this treatment.

Turning now to the question of deafness after mastoid operations, excluding radical ones, in the 881 non-treated cases there appear 81 who have had mastoid operations. These were emergencies, and had not been treated in any way for their loss of function. They were done at various institutions, and are a cross-section of the results from many sources. The proportion is roughly 10 per cent. of the whole group. In the children treated, the number of post-operative mastoids that were deaf was only 19, and these had received special consideration for their deafness by one surgeon.

We can, therefore, say that while 81 cases out of 881 occur in the non-treated group, only 19 out of 1,019 appear deaf in the treated group. These were tested twice, and out of 81 untreated ears on the second test, only 4 managed to pass, i.e. 4 spontaneously improved. In the treated cases three months later, the 19 were tested again, and out of those 7 passed, just over one-third.

If, then, after a mastoid operation, in which the hearing of the child, and all the factors associated with this, are taken into account at the time, we can expect that in 1,019, 12 cases will be deaf to a marked degree. All the others, should be well, whereas if the mastoids are allowed to become emergencies, the operation is done late, and merely regarded as a source of sepsis, the number we should have deaf out of 881 would be 77. This remarkable difference shows the improvement treatment always gives.

There is one group marked "normal ears". On inspection there is no history, no abnormality, and it was thought that some other factor, e.g. colds, etc., might be the cause of this deafness, and a second test was done. Here 69 cases passed, and we must conclude that in this group, one-half to two-thirds get better spontaneously. Thus we can say that by far the greater part of deafness in children of this city is due either to suppurative otitis media, and its sequelae, or to obstruction of the Eustachian tube and similar conditions, and is remediable.

Owing to the outbreak of hostilities and the cessation of this work, a follow-up has not been possible, but we are left with certain outstanding points.

Looking first of all at those cases which have received no ear and throat treatment, we are struck by the fact that out of 881 cases, over 600 are in the categories of deaf and dry—i.e. those which would not have been taken to the doctor with running ears. They are the results of suppuration which has ceased.

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Here are 261 cases where the ears have been running and have dried up, but despite this apparent natural cure they have a fairly grave disability

The same remark applies to the 295 retracted drums Here another process has occurred, but the net result is the same, a loss of function It would seem quite obvious that this is a clear and distinct proof of what has so often been said, and so much disbelieved, that the otoscope is no guide whatever to function after an ear is dry

In the cases treated the main group as shown lies in active disease These children came for treatment because the disease was more severe, accompanied by pain and discharge, and numbered 470 cases Twenty eight of these have dried up, and are still deaf, and many have to have radical operations, or some other kind of surgery, but their hearing will probably not be good in the end

It was my intention to make this paper merely a survey of what is happening apparently in many cities under the existing conditions, and the result is far from satisfactory The majority of these cases are avoidable, if only we can bring home to the profession and the public that a case of otitis media is a case of potential deafness, with the resultant economic disability therein entailed

Mr JAMES CROOKS Generally speaking chronic otorrhœa has its origin in acute otitis media, and acute otitis media has its origin in infection of the upper respiratory tract, and apart from congenital nerve deafness and deafness following one form of meningitis or another one rarely comes across deafness in the child which is not ultimately attributable to the state of the nasopharynx

For these reasons if we are to discuss usefully prevention of chronic otorrhœa and deafness we must concentrate on the nasopharynx

Not only is the initial acute ear disease the result of infection in the upper respiratory tract, but the presence of an infected focus in that situation is the common cause of the deplorable sequence of chronic otorrhœa from acute otitis media If all acute otitis were subjected to treatment, and if that treatment were always successful, chronic otorrhœa would not exist and deafness in childhood would be rare

Obviously there comes a stage, say with bone infection, when the establishment of a healthy nasopharynx will not suffice to cure disease in the ear, but at no stage, even after a radical mastoid operation has been performed, can the condition of the nose and throat be neglected, for, in such a case, if infection is still present, not only will the other ear be in jeopardy, but recurrent infection of the Eustachian tube leading to the radical cavity may give rise to troublesome discharge from that ear

I have analysed for the purposes of this discussion the condition of the nasopharynx in the last 50 children who have been in my ward for the treatment of middle ear deafness or recurrent or chronic otorrhœa The condition of the adenoids has, in all cases been confirmed by examination under anæsthesia and X-ray films of the nasal accessory sinuses of each child were made Behind these observations lies the much more complex problem of resistance to infection and of environment For example it is obvious that a child may have a naturally healthy nasopharynx, or may have attained such a condition by the aid of medical or surgical treatment, but still be subjected to severe and recurrent infection from his mother who gets tonsillitis or has a chronic sinus infection Or the child may suffer from repeated infections because of lack of

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immunity, or be subject to continual catarrhal nasopharyngitis as a result of malnutrition or poor hygiene. Our study of the prevention of deafness and chronic otorrhœa should therefore start further back than the customary realm of the ear, nose and throat surgeon.

But to return to the gross observations and treatments which are within our scope, and by which we can improve the state of the nose and throat so that the ear, in its turn, may benefit, not only is disease of the adenoids, and to a lesser extent disease of the tonsils, associated with disease in the ear, but also ear disease and sinus infection are closely associated. Though we realize the significance of sinusitis in the adult, we have been slow to acknowledge its frequency in childhood. Even on theoretical grounds it is likely to be common in the early years, when upper respiratory infections (including the infectious fevers, of which whooping-cough is a frequent cause of sinusitis) are more prevalent than in later life. Ear infections are admittedly more common in childhood than in adult life, and the genesis of infection in a sinus is the same as that of the ear. In every case of ear infection the condition of the sinuses must be investigated. An X-ray film will often reveal disease in a sinus which would not have been suspected on clinical grounds. Of course not every opaque sinus is full of pus, or even muco-pus, and marginal opacity may be merely local evidence of generalized swelling of the mucosa of the upper respiratory tract, which would call for general treatment rather than treatment directed primarily towards the sinuses.

Of the 50 children who were admitted to my ward with obstinate or complicated ear diseases 34 had catarrhal and recurrent otitis media and 16 had chronic suppurative disease. Of the first group 12 had tonsils and adenoids present, and it was disappointing, reflecting as it does upon surgical technique, to find that 17 others had adenoid remains; 15 had radiological evidence of sinus infection, and in 8 of these pus or muco-pus was washed out of the antra, in some cases on numerous occasions; while in only 2 was the condition of the nasopharynx and sinuses healthy, if we exclude those whose tonsils and adenoids were present but may have been apparently normal. While of the 16 children with chronic suppurative otitis the tonsils and adenoids were present in 4, adenoid remnants in 8, and the sinuses were infected in 3. There was no obvious focus of infection in 3.

It was considered advisable to remove the tonsils and adenoids of all the children. Adenoids are such a frequent cause of ear trouble and vary so much in size and condition from time to time that I would find it difficult to say with certainty that adenoids could safely be left in any child with otitis media.

The adenoid remnants which were removed were often of very considerable size, sometimes huge, and containing accumulations of caseous matter. In my experience adenoid remnants give rise to much more trouble, both in the ears and in the nasopharynx, than do virgin adenoids of the same size. Particularly harmful to the ears is the hypertrophied lymphoid tissue which is so often left at the sides of the nasopharynx. It has to be admitted that the difficult operation of removal of adenoids is often very inadequately performed, with serious consequences to the ears.

Captain E. P. FOWLER, Junr. (United States Army) said that in the treatment of otitis media the question of sensitization to the sulphonamides was

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important This was very troublesome if it became necessary to give the drugs a second time It had been found, particularly with sulphathiazole, that something like 37 per cent of patients who had previous doses for any disease develop a sensitivity He therefore reserved sulphonamides for meningitis, lobar pneumonia and other serious diseases, rather than using it routinely for ordinary otitis He knew of one case in which sensitivity lasted for two years

In America phonograph audiometer routine testing and examination was started in 1920-21, by E. P. Fowler, Senr, but a great deal of apathy had to be overcome In New York 800,000 children were tested for three years It was discovered that there was even an economic gain In addition to the advantage of having children start out in life without the handicap of deafness, which made them appear stupid, it was found that the cost of sending technicians to the schools to test the children was less than the cost of having these same children repeat their classes year after year because they could not hear the teacher The testing actually saved money for the Board of Education

Incidentally there was a seasonal incidence of changes in hearing It had been found that the audiometer readings were better in the spring and summer Apparently in the summer the adenoids were less swollen so less deafness occurred The experience might not be the same in the different climate of Great Britain

He had tried to deal with the adenoid remnants which had been mentioned by Mr Crooks It was often impossible to remove the most important of these tiny remnants by surgery, and he had seen serious results caused by eminent surgeons who had been too radical in removing them surgically He now followed the method of Crowe of Johns Hopkins who irradiated the nasopharynx in order to treat whatever was left in the adenoid region after an ordinary adenectomy was done He had done this in three different ways, but the simplest and easiest was to use a small capsule of radon gas which was put into an applicator the size of a nasopharyngoscope and slid through the nose into the nasopharynx With 250 millicuries eight minutes application to each side of the pharynx were necessary Usually three to four applications at five to six weeks' interval were enough Larger quantities of radon saved time but were proportionately dangerous to the operator

It had been suggested that the same results were obtainable with deep X ray therapy, and accordingly he carried out a series of cases with that method, but it proved to have certain disadvantages One of these disadvantages was that the patients had to come several times a week to get their treatment, and there was also the danger of treating other tissues than the ones it was desired to reach Later he had worked out a method for the employment of small quantities of radium to replace the radon as given by Crowe The time was longer but the total dosage of 66 mg hrs per treatment was the same Small children might be given an anæsthetic before the radium or radon was put in, and they were then examined with the nasopharyngoscope He commended that type of treatment and thought it well worth while for the prevention of recurrent otitis media and its consequent deafness

Dr J ALISON GLOVER said that chronic middle ear suppuration in school children was mostly found in entrants and diminished during school life year

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by year. Its frequency had steadily fallen. Thus in London it had been found in 3.7 per cent. of children examined in routine medical inspections in 1911: in 2 per cent. in 1920; in 1 per cent. in 1930; in 0.8 per cent. in 1935; in 0.6 per cent. in 1938, and in 0.3 per cent. in both 1940 and 1941. The incidence was thus only one-twelfth of what it was thirty-one years ago.

It was definitely a "poverty" disease owing to the higher incidence of acute otitis media due to the earlier age incidence of measles and other infectious diseases of childhood in poorer families; and their environmental conditions, e.g. overcrowding, and sleeping more than one in a bed, leading to higher hæmolytic streptococcal carrier rates and greater liability to respiratory complications.

There was also a greater tendency for acute otitis media to become chronic due to the delay in securing and maintaining treatment, as less importance was attributed to the "running ear" by the poorer parents; to neglect of nasal hygiene, and to partial dietary deficiencies, particularly of vitamins A and C.

Apart, therefore, from local treatment, and treatment for associated conditions (particularly sinusitis), the indications for general treatment seemed to be an open-air régime, preferably residential, correction of nutritional deficiencies, and the postponement of measles to as late an age as possible by such schemes as the London measles scheme. The education of parents in the importance of the "running ear" and the need for early treatment was fundamental to the prevention of chronic middle-ear suppuration.

Just before the war the Board of Education published the report of the Committee of Inquiry into Problems relating to Children with Defective Hearing (H.M. Stationery Office, 2s. 6d. net). Owing to the war the Board had been unable to implement the recommendations, which, he was sure would be found satisfactory by the Section, and which would meet most of the constructive suggestions made during the discussion.

Dr. J. N. DOBBIE (Public Health Department, L.C.C.) said that Dr. Alison Glover in his recent Chadwick Lecture had pointed out how the School Medical Service in dealing with otitis, had proceeded from ascertainment to treatment and finally to prevention. It was necessary to go back quite early to see where the origin of these ear troubles lay. The range of treatment was wide, and special attention should be paid to this subject in the medical curriculum so that some consistent approach to the problem might be made. Prevention called for much more study. The parents must be educated by the doctors themselves. Students should be taught that it was of little use looking to treatment only without regard to real causes, such as home and social conditions.

During the last three years there had been an enormous evacuation of London children to the country where at least they had the advantage of more open air. At the beginning of 1942 the L.C.C. school doctors—and 75 per cent. of this work was done by general practitioners—said that they had been particularly impressed when examining the children during 1941 with the statistically significant drop in the incidence of ear disease. The only reason he could assign to it was that these children had had for the first time in their lives a change of environment and an improved nutrition.

Mr. W. M. MOLLISON said that obviously education should begin at the

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child's first year, for the bulk of these cases took their origin in the years between birth and 5. Recently he had seen a good many recruits for the Services who had been rejected because of running ears, and it had been brought home to him that between school leaving age at 14 and entering national health insurance they had received no treatment.

Mr J C Hogg said that during the past twelve years he had been aural surgeon to elementary school clinics on the outskirts of London, and for seven years he had been seeing cases referred from the welfare centres run by the urban district council. It was found that the incidence of otitis media had considerably decreased among the elementary school children of that area. The mothers were becoming educated to take their infant children to the welfare centre for advice, and again in many cases the medical officers attached to those welfare centres were now on the look-out for otitis media. They referred such cases to the school centre, where they were examined, and he was glad to say that he did not believe that there had been during the last seven years any cases of acute otitis media among infants which had failed to respond to conservative measures. In this particular school centre the children were examined by the assistant school medical officers on entry, that is, at the age of 5, when they were sorted out, and all ear, nose and throat cases were referred to a specialist. They were examined again at the age of 10, and the cases which called for such a course were referred again to the specialist, and at the school leaving age they were once more examined and referred if necessary.

He agreed with Mr Mollison that the gap between school leaving age at 14 and at the age at which these persons became eligible for the Services was a serious one. The records of the militia boards showed that these cases had had treatment at school, but nothing had been done since leaving.

ABSTRACTS

BRONCHI

Bronchoscopy in the diagnosis and treatment of Bronchiectasis in Children

Dr D E S WISHART (Toronto) *Jour A M A* December, 1942 cxx

Bronchography for the purpose of demonstrating the location and severity of bronchiectatic lesions has been used at the Hospital for Sick Children, Toronto since December 1927. The technique is given in detail and the results are described in this paper.

Iodized poppy seed oil is put into the bronchial tree by the bronchoscope under general anaesthesia. Bronchiectasis now is frequently diagnosed and the number of cases labelled as either chronic bronchitis or unresolved bronchopneumonia has become proportionately less. Children of every age from infancy upward and with the severest types of bronchiectasis have been investigated and treated. Patients under 2 years of age have been bronchographed and under 1 year of age have been suctioned without any complication. The bronchography under general anaesthesia and without sedation is performed on a fluoroscopic table and thus the injection of iodine

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be followed by radiologist, attending physician and bronchoscopist. Prolonged adequate evacuation of the bronchial secretions is essential. The mere introduction of iodized oil into the bronchial tree is not sufficient. The oil must reach the diseased portion of the bronchi in sufficient but not too great quantity and remain there long enough to allow the radiologist to make the necessary exposures. The total number of embarrassing complications following 1,275 lipiodol injections or suction in bronchiectatic cases was seven. Only one death that can be ascribed to injection of oil occurred in the entire series. Overfilling of any part of the lung renders the radiogram useless for visualization. Fallacies to be avoided; contra-indications, surgical cures by lobectomy; the pathological conditions found; are discussed. The treatment of bronchiectasis in children is described in some detail.

The author believes that bronchoscopy, together with bronchoscopic suction, injection of iodized oil under general anæsthesia and bronchogram has proven of unquestioned benefit in the study and treatment of bronchiectasis in children. These procedures determine which children are suitable for the only cure known—major surgery. These preliminary studies disclose the cases where major surgery is contra-indicated. The degree of the existing disease is ascertained. Bronchoscopy provides the most effective form of treatment of the large group which do not require major surgery. Bronchography permits the early definite diagnosis of the disease and, therefore, affords the great hope that the further progress of a most devastating disease can be checked.

ANGUS A. CAMPBELL.

LARYNX.

Cancer of the Larynx. MAX CUTLER, M.D. (Chicago). *Jour. A.M.A.*, October 19th, 1940, cxv, no. 16.

The writer bases this communication on three hundred cases seen during the last ten years. A "radiosensitive" tumour is defined as one that can be completely sterilized without damage to the surrounding normal tissues. It is almost impossible to draw a fine line between "radiosensitive" and "radioresistant" tumours.

Cancer of the larynx is divided into four types: (1) laryngeal vestibule (epiglottis, false cord), (2) ventricular cavity, (3) vocal cord, (4) subglottic area.

Six illustrative cases are reported describing the lesions and results of treatment. The microscopic structure of a biopsy specimen is of some help in estimating prognosis and in guiding treatment. Its value, however, is distinctly limited and unless the microscopic changes are interpreted in the light of clinical and gross anatomical factors the biopsy alone may be highly misleading. The specimen taken for biopsy may not be representative of the actual lesion. This error may be diminished by taking specimens from different portions of the lesion. When biopsy discloses a highly undifferentiated carcinoma it may be assumed that the lesion is of this type, but the contrary is not true. If the biopsy shows a highly undifferentiated carcinoma, the radiosensitivity of the lesion may be predicted with reasonable certainty but its radiocurability is dependent on the extent of the disease, the general condition of the patient, efficiency of the treatment and other factors of a biological nature which are not understood.

Nose

Carcinoma arising in the false cords and epiglottis is generally undifferentiated and radiosensitive. Carcinoma arising in the true cord is generally differentiated, and its radiosensitivity depends on the presence or absence of invasion of other tissues.

Mobility of the lesion and the surrounding structures is a most important clinical sign and is the most important indication of radiosensitivity. Radio sensitivity of carcinoma of the larynx cannot be determined on the basis of microscopic structure alone.

The article is freely illustrated and has a bibliography.

ANGUS A CAMPBELL

NOSE

Normal and abnormal Bacterial Flora of the Nose LEON ORRIS JACOBSON M D
and GEORGE F DICK, M D *Jour A M A* December 27th 1941,
cxvii no 26

The writers base their studies on cultures from the nasal secretion from five hundred consecutive patients admitted to the general medical ward. None of these patients was admitted because of a primary complaint in the nose or para nasal sinuses.

The normal nasal flora consists chiefly of staphylococcus albus and diphtheroid bacilli with staphylococcus aureus and micrococcus catarrhalis less frequently. The presence of streptococci, pneumococci, bacillus mucosus, Pfeiffer bacilli and diphtheria bacilli indicates disease of the nasal mucosa, sinus disease or both.

Green forming streptococci and pneumococci are occasional transients of the nasal cavity. The frequency with which green forming streptococci, haemolytic streptococci and pneumococci were isolated by culture of nasal secretion in acute or chronic sinusitis shows the diagnostic value of this simple and inexpensive procedure.

The article has five tables and a bibliography.

ANGUS A CAMPBELL

MISCELLANEOUS

Vitamins for the Prevention of Colds DONALD W COWAN M D
HAROLD S DIEHL, M D and A B BAKER, M D (Minneapolis) *Jour*
A M A, December 19th 1942, cxl, no 16

During the school year 1939-1940, four hundred and twenty-seven students were enrolled in the "cold prevention group". In order to exclude from the study persons whose difficulties seemed to be due primarily to chronic sinusitis or allergic rhinitis, special attention was paid to the nose and throat and to symptoms suggestive of allergy.

One group of students was given tablets of synthetic ascorbic acid while the control group was given placebos. The ones who took the vitamin C supplement had a slight advantage (3 per cent) in reducing the number of colds. On the other hand they had more complications such as bronchitis, otitis and sinusitis than those in the control group.

Abstracts

During the school year 1940-1941, two hundred and sixty-four students were divided into similar groups. These were given multiple vitamins containing A, B, B₂, C and D and nicotinic acid. From the tabled results no evidence was revealed that multiple vitamins reduced the severity of colds. The average duration of each cold was the same for both groups and complications were more frequent among the students who got the vitamin supplements than in the control group.

The students were presumed to be on a reasonably adequate diet.

AUGUS A. CAMPBELL.

Pulmonary Tuberculosis masquerading as Laryngitis. JOSEPH C. DONNELLY, M.D. (Philadelphia). *Jour. A.M.A.*, October 31st, 1942, cxx, no. 9.

When a patient complains of chronic hoarseness or sore throat, pulmonary tuberculosis should always be in the mind of the physician. A critical analysis of twenty-six patients shows that the laryngeal symptoms were the first manifestations of pulmonary disease. The chief misleading factor is the apparent well being of the patient whose latent pulmonary and systemic signs are masked by laryngeal symptoms.

Unfortunately laryngitis is not a sign of early tuberculosis since several cases showed far advanced pulmonary lesions several weeks after the initial onset of the laryngeal symptoms.

The presence of ulceration or oedema is a bad sign, while the finding of a tuberculoma signifies a favourable prognosis. The prognosis is definitely better when only the interior of the larynx is involved.

The article is illustrated, has four tables and a bibliography.

AUGUS A. CAMPBELL.



THE MECHANISM OF SWALLOWING

By V. E. NEGUS (London)

Methods of swallowing.—A simple type of protozoon such as amoeba engulfs food by protoplasmic flow; part of the organism wraps itself round the particle and ingests it. In higher types this unicellular action is replaced by a multicellular mechanism, in which many cells combine to engulf food by concerted action. Longitudinal muscle fibres contract and pull part of the food tract over the bolus, which is then prevented from escaping by contraction of circular fibres and is carried downwards by their peristaltic action. Sebileau and Truffert³⁷ used the word "happer"—to snap up—in describing the movement of elevation over a bolus. As the wave descends there is relaxation of the longitudinal muscle and thus a section of the food passage descends, carrying with it the enclosed mass of food. Such a mechanism may be watched in snakes, which seem to creep forward over their prey. A rabbit, for instance, when swallowed, remains almost stationary, the snake moving forward over it until it has completely engulfed its victim. A simple mode of swallowing is employed by the earthworm (lumbricus) which grasps food with its prehensile mouth and then squeezes it onwards by contraction of its muscular pharynx. A somewhat similar mechanism is to be discerned in mammals and man if various complicating factors are ignored.

Alternative methods.—An alternative method is that of ciliary action, as seen in vorticella amongst unicellular organisms and also in molluscs, such as oysters, in amphioxus, and in amphibia, as for example the frog (rana). In the latter, cilia extend into the oesophagus and may be observed to possess sufficient power to convey pieces of paper from the front of the mouth into the gullet. In man the use of ciliary action is confined to the conveyance of bacteria and particles of dust from the nose and sinuses to the nasopharynx.

Other purposes of swallowing.—Not only does the mechanism convey food to the stomach, but in certain species it also subserves the functions of smell and respiration. Some fish, for instance, induce a stream through the olfactory organ and carry water to the gills by swallowing movements, while lung fish (dipnoi) transfer air to the lung by a similar method.

In man the ingestion of food is the most important use of swallowing; but subsidiary purposes are the removal of bacteria from the nasopharynx, where they are deposited from the nose, the paranasal sinuses and the middle ear. Bacteria from the lungs are carried upwards

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through the larynx by ciliary action and are deposited in the pharynx, to be swallowed and destroyed in the acid secretions of the stomach.

Modifications due to mastication.—The concerted action of longitudinal and circular muscle fibres is able to propel food, and is efficient in such simple animals as earthworms, which live on small particles, grasped by the prehensile mouth. When large masses are swallowed, as in carnivorous fish and reptiles, some efficient means of seizing and holding the prey is necessary and takes the form of teeth, but without other modification of the simple mechanism. In snakes the teeth are set back so that the prey when caught cannot escape; the teeth are not used for mastication. Crocodilians similarly use their teeth for prehension only. If food is divided up in the mouth, instead of being ground up in the gizzard, as in earthworms and birds, or digested in the stomach, as in reptiles and crocodilians, grinding teeth are necessary; the chewing process also requires the presence of a tongue to force food between the teeth, and cheeks to prevent escape of the divided mass.

Function of cheeks and lips.—Cheeks are almost absent in amphibians, reptiles and birds and are but poorly developed in carnivorous mammals. Herbivora, on the other hand, have efficient cheeks capable of retaining masticated food; man is similarly well provided. Mobile and prehensile lips are associated with efficient cheeks, as may be noticed in monkeys, apes and man.³⁵

Uses of tongue.—The tongue is used not only for purposes of mastication but also for prehension, as in chameleons and toads, where it is used for catching flies; herbivora, such as giraffes, carry leaves to the mouth with their long prehensile tongues. A further function of the tongue in many animals is propulsion of food into the pharynx; in man the organ arches up and is pulled back by the palatoglossus and styloglossus muscles, thus tipping food into the pharynx. Some carnivora, such as crocodiles have a flat and relatively immobile tongue, unrequired for mastication, unsuited to prehension and of little use for propulsion; others, for example dogs, have a mobile tongue capable of forcing unmasticated lumps of food backwards. The absence of tongue and cheeks sometimes makes the swallowing of lumps of food difficult, as may be noticed in the hen, for instance; this and other birds make snatching movements by jerking the head forward, thus utilizing the inertia of the bolus as a means of engulfing it. In man total removal of the tongue does not lead to inability to swallow, owing to the compensatory action of the cheeks and floor of the mouth.

First or buccal stage of swallowing in man.—Prehensile lips assist in grasping food, which is masticated by combined action of the tongue and teeth; the latter are adapted to grinding but are not so efficient as in the progenitors of modern man, owing to reduction of the palate area. Well-formed and muscular cheeks prevent escape of masticated

food. The bolus is forced backwards by raising of the floor of the mouth, mainly by action of the mylohyoid muscle, with arching and backward movement of the tongue amongst the muscles concerned in these two movements are the intrinsic muscles of the tongue, the hyoglossus and the stylo- and palato-pharyngeus. The backward movement of the tongue temporarily obliterates the lumen of the pharynx, while the isthmus of the fauces is at the same time narrowed. When the bolus passes the fauces it enters the pharynx, where certain difficulties arise in its transference, due to the necessities of respiration: The passage of the bolus from this point to the mouth of the œsophagus is called the second stage of swallowing. Various considerations in connection with modifications of the mechanism in this region must now be considered.

Modifications due to presence of larynx.—The development of a pulmonary outgrowth does not of itself involve any radical change in the mechanism of swallowing. In lung fish (dipnoi) for example, the larynx is small and lies flat in the floor of the pharynx; similarly in such reptiles as tortoises, crocodiles and lizards and in birds, movements of the longitudinal and circular muscles are not impeded by the larynx. Deglutition takes place as one continuous action, after initial prehension of food and its passage through the mouth; but in other higher animals the larynx has a marked effect on the mechanism.

Complications caused by nasal respiration.—Even though the evolution of a pulmonary system does not necessarily have a pronounced effect, yet the habit of breathing through the nose may introduce certain modifications in species where it is necessary for the nasal and laryngeal airways to be continuous. Such a relationship is evolved for various reasons, depending generally on the desirability of maintaining nasal respiration when the mouth is open.

Reptiles have poor powers of scent and do not derive any particular benefit from breathing through the nose in respect of olfaction. Keen-scented animals are, however, in a different category and accordingly show certain alterations of structure.

Modifications due to presence of epiglottis.—If it is desired to preserve the integrity of the olfactory sense when the mouth is open, whether for selection of suitable food, or to detect the presence of enemies, it is necessary for the airway to be shut off from the food tract. The epiglottis is evolved for olfactory purposes, to form a barrier against mouth breathing, by coming into relationship with the palate.³⁰ Most amphibians, reptiles and birds are devoid of an epiglottis, but keen-scented mammals are provided with an efficient flap which lies either below the palate or above it in the nasopharynx; the palate is elongated to complete the junction.

Herbivorous animals such as deer and cattle and hunters like the members of the dog tribe show this structural arrangement. To ensure

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efficient coaptation of the larynx and nasopharynx lateral palatine folds descend on either side of the epiglottis, with palatoglossal and palatopharyngeal muscles enclosed within their layers. Contraction of these muscles keeps the palatine folds taut, and brings them efficiently into contact with lateral epiglottic folds, thus ensuring passage of air over the olfactory nasal mucous membrane even when the mouth is open, as during cropping of herbage.

When the ingestion of any large bolus takes place the palatine folds must be separated from the epiglottis to give free passage, deglutition is then divided into three stages, the first through the mouth, the second past the larynx and the third through the œsophagus.

Man relies for his preservation on vision and not on his sense of smell, and has therefore no need of this intimate relationship of laryngeal and nasal airways.

Combined respiration and deglutition—Animals such as herbivora, which eat large quantities of vegetable food, would be handicapped if respiration had to cease while food passed into the gullet. To overcome this difficulty the larynx is provided with high lateral margins, which in most species take the form of aryepiglottic folds. The larynx thus assumes a spout-like character, with a lateral food channel on either side. Further to prevent entrance of fluids there is evolved an arcus palato-pharyngeus, a fold made up of the fused palatine arches meeting posteriorly, with an enclosed palato-pharyngeal sphincter, designed to grasp the laryngeal aperture and thus to shut off the lateral food channels from the airway. This structure is present in most herbivora and appears, in its most efficient form, in cetaceans such as porpoises, dolphins, and some whales. Foetal marsupials attached to the maternal nipple and fed forcibly by the mother, show the mechanism well. Man has abandoned the purely herbivorous habits of his ancestors and with his mixed diet has no need of an efficient lateral food channel. A further reason for his departure from the herbivorous type of lateral passages is the recession of the jaws and the flexion of the head on the vertebral column, the larynx has descended in the neck, being forced to do so by the tongue, which assumes an arched shape³⁵. The result is the separation of larynx from nasopharynx, with a wide gap between epiglottis and soft palate, and the formation of a capacious and lengthy pharynx. There is an angle of almost ninety degrees between the mouth and pharynx. The descent of the larynx in the neck and the absence of any close relationship with the nasopharynx, make it essential that both nasal and laryngeal passages should be closed during deglutition, to prevent inundation. Only when very small quantities of liquids, food or saliva are passing is it possible for the laryngeal aperture to remain open.

Mechanism of the nasopharynx—Closure of the nasal airway is a complicated action in which several muscles play a part. As food is

forced back into the pharynx, reflex stimulation of the posterior wall initiates a swallowing movement,²⁷ commencing in the highest part of the nasopharynx and travelling down as far as the mouth of the œsophagus. The first movement appears to be carried out by longitudinal elevator muscles, the levator and tensor palati, closely followed by the salpingopharyngeus and the palato-pharyngeus. The uppermost fibres of the latter are almost horizontal and act as the sphincter of the hiatus nasopharyngeus, situated just above the lower border of the soft palate. This view of the anatomy is taken by Wood Jones, who refers to the observations of Townshend²⁰; previously the sphincter had been ascribed by Wardill⁴¹ and Whillis⁴² to fibres of the superior constrictor.

The primary movement of the elevator muscles leads to raising of the soft palate and closure of the nasopharyngeal isthmus by approximation of all its walls; initial closure is followed by a wave of constriction, effected by the superior constrictor muscle, with the object of squeezing out mucus, debris and bacteria, dumped by the ciliary streams of the nose and sinuses, to be carried downwards through the pharynx into the œsophagus and stomach.

When the mechanism is upset, as in the paralysis sometimes following diphtheria, there may be regurgitation into the nose. Scarring and immobility may lead to stagnation of infected secretions, with consequent droplet infection of the lungs.

Closure of larynx during deglutition.—When any considerable quantity of food or fluid is swallowed, respiration ceases and both nasopharynx and larynx close. At the beginning of the second stage of deglutition the larynx rises with the rest of the pharyngeal tube. Contraction of the thyrohyoid muscle, together with the upward pull of the palato-thyroideus,²⁰ causes the thyroid cartilage to ascend beneath the hyoid bone, thus bringing the whole larynx into apposition with the base of the tongue. At the same time the sphincters of the larynx contract, while the dilators relax, in order to close the airway before food has the chance of entering.

The simple sphincter of lung fish is represented in man by the paired lateral crico-arytenoid and thyro-arytenoid muscles and the single inter-arytenoid, with certain oblique fibres running from the latter to the epiglottis. A few strands pass the epiglottis to be attached to the hyoid bone, thus assisting in the elevation of the larynx.

In dogs some fibres may be seen passing from the sphincteric group to the anterior wall of the œsophagus, to assist in opening the mouth of the latter.³² Sébilleau has described similar fibres in the horse.³⁷ In man these fibres are less obvious, but there is an alternative mechanism with a similar function, namely suspension of the anterior wall of the œsophagus from the tips of the recurved cartilages of Santorini. These processes are tilted forward by the underlying interarytenoid muscle

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during swallowing, thus serving to close the larynx and open the œsophagus simultaneously.^{34, 33} In these movements the anterior wall of the hypopharynx is partially pulled up over the top of the cricoid cartilage, thus helping to close the laryngeal aperture.

It is generally recognized, in agreement with Anderson Stuart³⁹, that the epiglottis does not serve as a lid for the laryngeal aperture; rather it appears to be squeezed between the base of the tongue and the upper boundary of the larynx.⁷ Many animals amongst the lower orders, and walruses and sea lions amongst mammals, are provided with no more than a rudimentary organ and yet suffer no inconvenience; nor does a man whose epiglottis has been removed.

Although the larynx of man may remain open when small quantities of fluid pass along the lateral food channel, yet insufficiency of the latter makes it necessary for closure to take place when any large amount is swallowed. Even so the food stream does not habitually pass over the larynx, but is diverted to one or other side. Observations have been recorded by Grahe⁸ to show that the lateral food channel of one side only is used by most individuals, to the exclusion of the opposite side. This may have some bearing on the causation of malignant disease in the pyriform fossa.

In many animals, as already noted, closure of the larynx during deglutition is not necessary.

Mechanism of second or pharyngeal stage in man.—Having traced the evolutionary changes which have divided swallowing into three stages, it is now desirable to study further the second stage, in which food passes from the level of the palatine folds to the mouth of the œsophagus.

In man, the descent of the larynx, dependent on flexion of the head and retrogression of the jaws, has considerably increased the length of the pharynx³⁵ and has altered the anatomical distribution of the longitudinal and circular muscles; but there seems no good reason to think, with Ledoux,²⁵ that the mechanism is materially changed.

The longitudinal or elevator muscles consist of the stylo-pharyngeus, palato-pharyngeus and palato-thyroideus, working in association with the levator and tensor palati, the salpingo-pharyngeus and the elevators of the hyoid bone and larynx; of the latter group the stylohyoid and thyrohyoid are important members. Clarification of the distribution has been made by Wood Jones.²⁰ The circular group is made up of the three constrictors. The latter differ in their arrangement from the corresponding muscles of mammals, the fibres of the inferior constrictor having a considerable upward inclination from their origin on the larynx to their insertion in the posterior median raphe. But the mode of action of the pharyngeal musculature appears unchanged, as may easily be observed in the pharynx of a partially anæsthetized patient whose mouth is widely opened.

Each movement of swallowing can be seen to consist of primary elevation, in which the fibres of the middle and inferior constrictor are brought into a more horizontal position, followed by a peristaltic wave of constriction flowing rapidly and smoothly down the tube-like pharynx. The larynx, forming part of the anterior wall, rises with the rest of the pharynx and again descends when the bolus is engulfed and carried downwards to the mouth of the œsophagus; the whole wall of the pharynx rises and falls in this multicellular engulfing movement. Ledoux, in contradistinction, considered the middle and inferior constrictors to act as elevators of the larynx and described the longitudinal muscles as accessory elevators.

Although this peristaltic mechanism is not always required in man, yet it is available and is essential in such animals as giraffes, whose food passage slopes upwards during feeding. Considerable force may be exerted on a bolus of food, as noted in cases of pharyngostome. Bilateral paralysis of the muscles, as in bulbar palsy, may lead to inability to swallow, while unilateral paralysis, due to such conditions as thrombosis of the posterior inferior cerebellar artery, causes considerable disability, with lateral movement of the affected side during contraction of the opposite and active constrictors. This is the curtain movement described by Vernet.⁴⁰

There may be, in addition, lateral deviation of the thyroid cartilage, the sign of Adam's apple referred to by Ledoux.²⁵

The opening of the pharynx at the beginning of the second stage appears to depend on contraction of the elevator muscles, with relaxation of the palato- and stylo-glossus.

The lumen of the pharynx thus opens up as the backward push of the tongue ceases. It is again closed by the peristaltic wave of the constrictor muscles; but before this wave descends, the bolus of food, if not too hard or bulky, may have passed rapidly down the opened pharynx. The question of the suction effect stressed by Barclay,^{1,2,3} will be referred to later.

Closure of mouth of the œsophagus.—In animals which draw air into the lungs by expansion of the thorax and descent of the diaphragm, the bellows action would, if no barrier existed, suck air more readily into the œsophagus than into the lungs.

To prevent this undesirable occurrence, the crico-pharyngeal sphincter is present at the mouth of the œsophagus to keep the gullet closed during respiration, as described in previous contributions.³¹ Insufficient interest has been taken in this important muscle band, and although it was described many years ago, yet no reference to it is made in most textbooks of anatomy and physiology. Keith²¹ recognized the sphincter as being constituted by the lowest part of the inferior constrictor, the upper part of which has a propulsive action. He referred to its relaxation

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in the act of swallowing and wrote "Like the sphincter at the pylorus, that at the upper end of the œsophagus is continually in action, except during the initial act of swallowing" He mentioned that, unknown to him, a description had already been given by Killian,^{22 23} and he also referred to the writings of Sir Everard Home,¹⁰ who compared the sphincter to that of the urethra

Chevalier Jackson^{15 16 18 19} observed the obstruction offered by the sphincter on passing an œsophagoscope and described the muscle band as long ago as 1907, and subsequently in many contributions he gave prominence to its importance in deglutition

Relaxation of the sphincter occurs when a signal is given by the sensory stimulation afforded by impact of a bolus of food on the posterior pharyngeal wall The mouth of the œsophagus opens as the larynx closes, while respiration is temporarily suspended

The fibres of the crico pharyngeus meet posteriorly in a median raphe continuous with that of the oblique fibres of the inferior constrictor They are anchored to the front of the vertebral column by virtue of atmospheric pressure, in addition to attachment of the covering bucco-pharyngeal fascia to the prevertebral fascia

When the sphincter is contracted there is a backward pull on the larynx When relaxation occurs, early in the second stage of swallowing, the larynx is released and tends to fall forward in response to contraction of the thyrohyoid and other muscles The capacity of the pharynx is thus increased, affording a clear space for downward passage of food, as stressed by Barclay^{2 2 3}

The sphincter receives its motor supply from the nucleus ambiguus through the vagus and its recurrent branches, the sympathetic sends fibres also and, according to observations of Lambert Rogers,³⁶ they all come from the superior cervical ganglion By removal of the sympathetic supply Lambert Rogers has produced relaxation of the sphincter, it may therefore be concluded that the vagus is the relaxor and the sympathetic the contractor of the muscle band The vagus thus has an opposite action on the oblique and circular fibres of the inferior constrictor muscle, with contraction of the former and relaxation of the latter The sympathetic is reputed to augment the action of the vagus in the upper third of the œsophagus²⁴ but apparently it has an opposite action on the sphincter The crico pharyngeus remains in contraction when the inferior constrictor and muscles of the upper œsophagus are relaxed, all being controlled by the vagus, propulsive waves in the pharynx during deglutition are associated with relaxation of the sphincter, the sensory fibres of the vagus giving the necessary signal But when there is prolonged irritation of the lower pharynx or upper end of the œsophagus—either from the presence of a foreign body, a neoplasm, acute or chronic inflammation or ulceration—initial

swallowing efforts to dislodge the cause of irritation are succeeded by lack of relaxation or achalasia.¹³ Sometimes increased contraction, even amounting to spasm, is present. This reversed effect of excessive sensory stimulation is remarkable.

Deficient relaxation of the sphincter appears to be an important factor in the causation of pharyngeal diverticula¹⁸; the bolus of food, forced down by peristaltic contraction of the constrictors, causes herniation of the weak and relatively unsupported area between the lowest oblique fibres of the inferior constrictor and the crico-pharyngeal sphincter, as described by Keith.²¹ On the other hand, undue relaxation of the sphincter may permit air sucking or air swallowing, with distension and subsequent dilatation of the entire thoracic œsophagus, leading to œsophagectasia, with all the signs and symptoms of the disease usually known as cardiospasm.³⁴ This theory of primary dilatation probably applies to many cases in which no primary obstruction is present.

Animals with no lungs, those with infrabuccal bellows and those filling the lungs by swallowing movements have not the same need as man of a sphincter at the mouth of the œsophagus.

Passage of food into and through the œsophagus.—It has been mentioned above that relaxation of the crico-pharyngeal sphincter is followed by increase in the capacity of the pharynx. The sudden opening of the œsophagus allows the normally reduced intrathoracic pressure to exert a suction effect, particularly during the inspiratory phase of respiration. It is thus possible for food to drop through the laryngo-pharynx into the funnel-like mouth of the œsophagus in advance of the peristaltic wave which descends to propel any lagging bolus. This suction action was described by Maissiat²⁶ and has been brought into prominence by the radiological studies of Barclay.^{1, 2, 3}

The rapid rate of progress may continue in the upper part of the œsophagus, after which partial equalization of pressure, incidental to opening of the sphincter, leads to slowing of the bolus. In this connection it is stated that reflex inhibition of tonus of the upper end of the œsophagus accompanies relaxation of the crico-pharyngeal sphincter, thus delaying the commencement of the peristaltic wave.³⁸

Through the remainder of the œsophagus, passage of the bolus may be effected by gravity, but the normal propelling force is muscular action; by co-ordinated action the elevating longitudinal and sphincteric circular components execute movements of engulfment, shortening being succeeded by a peristaltic wave. That peristalsis is a means of propulsion of food is shown by the ability to swallow with the head lower than the body, as in human beings lying on an inclined bed, or in animals with long legs.

The nerve supply of the œsophagus has been the subject of a considerable amount of experimental work; the observations of Knight²⁴ have clarified the position. The vagus gives branches to the musculature,

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both from its main trunk and also through the recurrent laryngeal nerve ; it produces, by its action, increased tonus in the thoracic œsophagus. Stimulation of the supply to the upper third causes temporary tetanic contraction ; the sympathetic has a contributory effect. In the middle third stimulation of the vagus increases tonus, augmented by the sympathetic ; in the lower third the vagus acts in a similar manner but is opposed by the sympathetic.

Paralysis of both vagus nerves causes dilatation of the œsophagus, with decreased motility ; peristalsis later recovers in the lower third. The dilatation of œsophagectasia or cardiospasm cannot usually be due to decreased vagal action, however, since many cases show hypertrophy of the musculature and not wasting. Wide dilatation of the œsophagus, such as occurs in cases of cardiospasm and congenital shortening, makes the peristaltic wave ineffective ; swallowing of air has already been mentioned as a possible cause of the dilatation. Clinical and radiological observations show that patients with œsophagectasia rely on gravity as a means of carrying food onward. Peristalsis, under such conditions, cannot bring the walls of the gullet into approximation and the muscular wave merely churns up the contents, with no propulsive effect. In attempts to close the lumen, so as to overcome the disturbance of the normal mechanism, the musculature may hypertrophy. This explanation appears, in the case of œsophagectasia with holding up at the diaphragm, to be as reasonable as that which considers the muscular overgrowth to be a response to obstruction ; the slight degree of the latter, to be referred to later, should readily be overcome if hypertrophy followed obstruction early in the disease, and wide dilatation should therefore not occur. As soon as the muscular hypertrophy fails to compete with the abnormal dilatation of the œsophagus there is only one method for conveyance of food into the stomach, and that is the force of gravity.

Mechanism at lower end of œsophagus.—It is not necessary, for physiological reasons, that any obstruction should be offered to the entrance of food or fluid into the stomach. On the contrary, it is desirable that the contents of the œsophagus should pass onward as rapidly as possible, since stagnation is liable to cause œsophagitis. But it is essential that regurgitation should be prevented, not only to prevent the loss of gastric contents, but also to avoid peptic digestion of the mucosa in the lower end of the œsophagus.

Once in the stomach the contents are constantly forced onwards towards the pylorus by muscular contraction and are only temporarily arrested by the pyloric sphincter, until of suitable consistency to enter the small intestine. In the opposite direction, however, there is normally little tendency for food to regurgitate, and but slight force is required to prevent its escape.

V. E. Negus

A cardiac sphincter has been referred to by many authors, but descriptions vary. Hurst considers it to be situated in the abdominal segment of the œsophagus, usually extending up to the level of the diaphragmatic hiatus.^{11, 13}

Cannon⁵ has shown that in the normal cat regurgitation from the stomach to the œsophagus is a common occurrence, the fluid again being returned to the stomach by peristalsis; but when the gastric contents become acid during digestion, their effect is to keep the cardiac sphincter closed, apparently to prevent regurgitation. Much experimental work has been carried out on the nerve supply of the sphincter; Hurst has studied the subject in detail.^{11, 12, 13, 14} The observations of Knight²⁴ may also be quoted. The sphincter is supplied by both vagus and sympathetic nerves; stimulation of the former causes relaxation, while the latter leads to increased contraction. The sympathetic fibres surround the celiac axis and left gastric arteries; excision of this supply causes the sphincter to become completely patulous, with consequent regurgitation into the œsophagus. In cats, division of the vagal supply to the œsophagus causes dilatation, with holding up of food by contraction at the cardia; division of the sympathetic fibres leads to cessation of all symptoms. Hurst believes that the cause of a similar condition in man is degeneration of Auerbach's plexus,¹⁴ with consequent blockage of the stimulus to relax. There is no dispute with these experimental findings in the cat, but other considerations appear to arise in man, both in normal deglutition and in diseased states.

All opinions consider the sphincter to be very feeble and in no way comparable to the sphincters of the bladder, the rectum, or the mouth of the œsophagus. It is easily forced by œsophageal contents, and in cases of œsophagectasia offers but little resistance to a mercury bougie, as observed by Hurst.^{13, 14}

I have never seen evidence of its existence on direct œsophagoscopy. As regards disordered action of the sphincter, if one exists, some have described over-action, producing the disease generally known as cardio-spasm; but there is no hypertrophy of the sphincter in this type of œsophagectasia.¹⁴

Others, and notably Hurst, consider lack of relaxation or achalasia to cause holding up of food in the œsophagus, with the proviso that the sphincter is situated just below the diaphragmatic hiatus, where the hold-up occurs, and not at the actual junction of abdominal œsophagus and stomach. But if the disease were caused by achalasia, hypertrophy of the œsophageal musculature, present in many cases, should easily overcome the feeble resistance of the sphincter, and in fact is thought by Hurst to do so in the early stages of the disease. Resistance by the sphincter alone does not appear to explain the progress of the complaint, in view of the feeble obstruction offered, even in severe cases.

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Further evidence as regards the cardiac sphincter is obtainable in those cases of short œsophagus with no organic stricture at the junction of œsophagus and thoracic segment of the stomach. When one passes an œsophagoscope in such a case the line of demarcation between œsophageal and gastric mucosa is obvious and sharply defined; but one does not see evidence of a sphincter. Furthermore it is common experience, in such cases, to find reflux of gastric secretions into the œsophagus, with peptic ulceration; Dick and Hurst⁶ in fact consider shortening of the œsophagus to be a common factor in this type of œsophageal disease. In a paper by Briggs and themselves it is stated that: "The cardiac sphincter appears to be permanently relaxed when the œsophagus is abnormally short and a portion of the stomach is above the diaphragm; this is in contrast with the normal condition, in which it is closed except when relaxation occurs in the last stage of deglutition."⁴ In view of the consensus of opinion that the cardiac sphincter is feeble, if in fact it exists, it is desirable to consider whether other means are available to prevent regurgitation from the stomach. I have long felt, and am not alone in my opinion, that local physical conditions are such as to make a muscular sphincter unnecessary.

Gubarof⁹ is quoted as believing in the theory of mechanical as opposed to muscular closure, and the Ducuings,⁷ who refer to his paper, also consider this possibility. Dick and Hurst⁶ refer to a cardiac valve, formed by the left lip of the abdominal œsophagus as it joins the stomach; they believe it to act in one direction only and to assist in preventing regurgitation, while offering no impediment to the entrance of food into the stomach.

A factor which appears to have been somewhat overlooked is the difference in physical conditions to which the thoracic and abdominal segments of the œsophagus are subjected. In the thorax there is normally reduced pressure, tending to open the œsophagus, while in the abdomen the pressure is raised, with mutual apposition of the viscera, thus closing the abdominal œsophagus.³⁴ The difference of pressure and degree of obstruction are greater during inspiration, due not only to expansion of the ribs and descent of the diaphragm, but also to contraction of the crura and narrowing of the hiatus. For this reason and not because of varying degrees of contraction of a sphincter, a bolus of food may be halted during inspiration, to enter the stomach when expiration commences; pressure in the abdomen is then reduced, while the intra-thoracic pressure is correspondingly increased.

A further factor of importance in closure of the abdominal œsophagus is the situation of the gullet in the liver tunnel of Mosher; it is here subjected to pressure from the left, exerted by the fundus of the stomach, especially when the air bubble is large. Distension of the stomach may be associated with an abdominal lesion such as gall-stones, gastric ulcer,

or chronic appendicitis, and may lead to increased obstruction, in some cases followed by œsophagectasia. The possible benefit of dividing the sympathetic supply to the region of the cardia, recommended by Knight,²⁴ may be explained by lessened inhibition of the gastric musculature, with diminution of stasis, and not by any effect on the cardiac sphincter. Kinking of an overlong œsophagus may add to the valvular obstruction and may necessitate œsophagolysis.

Mosher²⁹ has shown by detailed observations that the œsophagus folds on itself as it passes the left crus of the diaphragm; there is an alteration of direction from the vertical to the horizontal. The left lobe of the liver is in front of the horizontal segment and thus helps in its closure. He has also demonstrated a close relationship of the lung tips to the œsophagus.²⁸ The right lung tends to go behind and the left in front; the total effect is not only a change of direction, but also a twist of the axis and a tendency to kinking and occlusion of the lumen. The effect is most marked when the diaphragm is down; during its rise in expiration the œsophagus tends to straighten out and open. Mosher believes that a cardiac sphincter exists, but not in every subject; he is of opinion that the physical factors outlined are the cause of closure of the terminal portion of the œsophagus.

Jackson^{16, 17} considered specialized muscle fibres derived from the crura of the diaphragm to have a pinchcock effect; the lack of effective prevention of regurgitation during expiration by this means alone, if the fibres relax with the rest of the diaphragm, makes it necessary, however, to consider other possibilities. Jackson himself considered kinking of the abdominal œsophagus to play a part.¹⁶ The evidence available appears to support the view that physical factors produce a mechanical compressive effect at the level of the diaphragm, sufficient to prevent regurgitation and calling for a mild propulsive effort on the part of the œsophagus.

If the propulsive force diminishes or if the obstruction increases, there may be holding up of food in the œsophagus, with signs and symptoms of the disease generally known as cardiospasm.

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NERVOUS DISORDERS OF SWALLOWING*

By SIR ARTHUR HURST (Oxford)

Hysterical Dysphagia

INVESTIGATIONS carried out between 1908 and 1911 with a number of helpers on the sensibility of the alimentary tract showed that sensibility to tactile stimulation extends beyond the mouth as far as the junction of the pharynx and œsophagus, but not into the œsophagus. The œsophagus is, however, sensitive to cold and heat, though thermal stimuli produce no sensory response in the stomach, and distension produces a feeling of fullness, which merges into pain when the stimulus is increased. Consequently if food is masticated until it is semi-fluid and has acquired body temperature, its passage beyond the pharyngo-œsophageal sphincter is not appreciated, but if it is swallowed in unchewed lumps or whilst still very hot or cold its passage can be felt as far as the cardia. The œsophagus being a fixed organ, localization of the sensory response to thermal and distension stimuli is very accurate (Hurst, 1911).

Theoretically there is no reason why hysterical dysphagia should not develop in the form of paralysis or incoordination of the voluntary muscles concerned in the first two stages of swallowing, in which food passes through the sensitive bucco-pharyngeal cavity. It would, however, be very unlikely to develop in the œsophagus itself or at the cardia, as the passage here is entirely independent of voluntary action, and under ordinary conditions it is not felt, the food disappearing into the void after passing the pharyngo-œsophageal sphincter, except when it is very cold, very hot or in large lumps.

Dejerine (1911) described six cases of hysterical dysphagia in his monograph on *Psychonévroses*. In each case much weight was lost and recovery followed simple psychotherapy. The patients had become nervous for various reasons, and the dysphagia developed as a result of some trivial incident which drew their attention to the voluntary but normally automatic act of swallowing. I know of no other recorded cases of hysterical dysphagia, and in my own experience it is remarkably rare. Whereas in the last war I saw over a hundred cases of hysterical aphonia and over fifty of hysterical vomiting in soldiers, I saw no case of hysterical dysphagia. A good

* Read before the Laryngological Section of the Royal Society of Medicine, November 6th, 1942.

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many years ago I made this diagnosis in a few middle aged women, but I am now convinced that the majority were examples of the upper dysphagia and anæmia syndrome of Paterson. This is easily mistaken for hysteria, as it was by Plummer and Vinson, and Vinson in his recent book on *Diseases of the Esophagus* still describes it as hysterical, although there is certainly nothing hysterical about it. The following is a description of one of the few cases of true hysterical dysphagia I have seen.

A woman, aged 25, came to Oxford in 1942 from Dublin, where she had been out of work for five months, in order to get employment. She found congenial work and was much happier in this country than she had been at home. She therefore did not avail herself of the usual permission to return to Ireland on a fortnight's leave at the end of six months. Her mother heard of this and wrote her a very angry letter. She was much upset, and directly afterwards found she had great difficulty in swallowing. She thought this must be due to a lump which had recently appeared in her neck and which was actually a small parenchymatous goitre. Her dysphagia consisted in inability to convey the food from her mouth into her pharynx. She continued to chew and did not appear to make any effort to swallow, though she spoke of the food sticking in her throat. There was none of the inco-ordinated activity of the swallowing muscles seen in the upper dysphagia with anæmia syndrome (*vide infra*). She was not anæmic and there was no atrophy of the bucco-pharyngeal mucous membrane. The emotional upset was sufficient to make the patient liable to develop an hysterical symptom and the presence of the goitre suggested its localization. Simple explanation and persuasion brought about a rapid cure.

Dysphagia in Organic Nervous Diseases

Dysphagia may occur in various organic nervous diseases as a result of paralysis of the muscles concerned in the first and second stages of swallowing. The œsophagus itself and the cardiac sphincter are never involved. In *diphtheria* the toxin ascends by the lymphatics of the nerves from the site of the lesion to the central nervous system, where it puts the cells of the corresponding nuclei out of action. The paralysis of the soft palate, which results in regurgitation of food through the nose, and the rare pharyngeal paralysis which results in severe dysphagia, occur therefore only in the common faucial diphtheria and not when the primary focus is in a wound, the conjunctiva or elsewhere. The paralysis is nuclear in origin and generally develops in the second week, in contrast with the more widespread paralysis caused by diphtheritic polyneuritis which appears between the third and sixth weeks.

In the *motor neurone disease*, which includes progressive muscular atrophy and amyotrophic lateral sclerosis, dysphagia may occur if the vagal nucleus is involved in the last stages of the common form which

begins in the muscles of the hands. It always occurs in *progressive bulbar palsy*, the form which begins with the bulbar nuclei. Though *myasthenia gravis* is a primary muscular disease, it gives rise to a similar upper dysphagia, in which the first as well as the second stage of swallowing is affected. In the motor neurone disease the slowly progressive paralysis is unaffected by any treatment, and there is no variation in the course of each day, so that once nasal feeding is begun it has to be continued until death, which is not likely to be long delayed. In *myasthenia gravis* the dysphagia increases in severity as the day goes on, and considerable spontaneous improvement may occur from time to time, so that a patient who has had to be fed for a time by nasal tube may later be able to swallow quite well for weeks, months or years. Improvement in swallowing sometimes seems to be a direct result of the complete rest given to the muscles of deglutition by nasal feeding. Slight dysphagia can sometimes be controlled like the other symptoms by $\frac{1}{2}$ to 1 grain of ephedrine taken an hour before meals. In severe cases an injection of 1 to 2 mgm. of prostigmine may make swallowing possible for four or five hours, but it should be used only to tide over a period of great difficulty and not for long periods, as it may lead to increased weakness after the effect of the individual dose wears off.

Dysphagia is also a symptom of the acute bulbar paralysis which may follow vascular or inflammatory lesions involving the nucleus ambiguus. In one such case investigated with W. Johnson (Hurst, 1911) the dysphagia was found to be associated with complete loss of thermal sensibility in the œsophagus, and the tension required to produce the sensation of fullness was double the normal. This was doubtless the result of interference with the sensory functions of the vagal nerve supply to the œsophagus. Mollison (1929) has described cases in which dysphagia followed a hæmorrhage brought on by coughing in a woman of 80 with whooping cough and by vomiting in a man of 67 with food poisoning; both recovered.

In all forms of dysphagia due to organic nervous disease food of porridgy consistence is most easily swallowed, as fluids require more rapid action and lumps more powerful action than soft food.

The Upper Dysphagia with Anæmia Syndrome of Paterson

The occurrence of upper dysphagia in anæmic women was first recognized by D. R. Paterson in 1906. In 1919 he described it more fully, but his observations attracted little attention, so that when in 1922 Vinson of the Mayo Clinic wrote an account of the syndrome and referred to unpublished work of his colleague Plummer in 1914, it was generally regarded as an original observation. In 1926 I described a case as one of "Plummer Vinson syndrome" and unfortunately this name has ever since been widely used both in England and America. When,

shortly afterwards, I read Paterson's description, which was much more accurate than Vinson's, as he described the associated atrophic condition of the mucous membrane of the tongue, which I had also recognized, but which had been missed by Plummer and Vinson, who quite unjustifiably regarded the condition as hysterical, I suggested that the designation Plummer Vinson syndrome should be replaced by "the upper dysphagia with anæmic syndrome of Paterson".

Paterson's syndrome is much the most frequent cause of upper dysphagia. It occurs in about 15 per cent. of cases of the simple achlorhydric anæmia (also known as hypochromic or microcytic anæmia), which is common in women, especially between the ages of 30 and 50, but very rare in men. Severe cases which would be likely to come to the laryngologist are rare in comparison with the cases in which slight upper dysphagia is a minor symptom, so minor that the patients often do not mention it unless directly cross-questioned. The syndrome is the direct result of iron deficiency, which causes not only the anæmia, but also atrophy of the mucous membrane of the tongue and pharynx, cracks at the angles of a stiff and narrow mouth, loss of teeth, and spoon-shaped brittle nails. The atrophic condition of the pharyngeal mucosa results in a loss of sensibility, so that the afferent side of the reflex upon which the second stage of swallowing depends is impaired. The orderly activity of the muscles involved in the complicated act, an admirable description of which has recently been published by Negus (1942), is disorganized so that swallowing becomes difficult or impossible. The pharyngo-œsophageal sphincter is particularly involved, the normal relaxation which allows the passage of food from the pharynx into the œsophagus failing to take place (achalasia) or being actually replaced by spasm.

The iron deficiency is a result of a diet containing too little meat and green vegetables, generally associated with achlorhydria, which interferes with the adequate preparation for absorption in the intestines of such iron as is present in the food, and occasionally with small intestine disorders which prevent its complete absorption. In many cases there is also excessive loss of iron from menorrhagia.

Administration of 30 grains of iron and ammonium citrate three times a day is sufficient to overcome the anæmia and often to restore the atrophic epithelial tissues to their normal condition, even, as Waldenstrom (1938) has shown, when this occurs in the absence of anæmia. If treatment is delayed, the atrophic pharyngeal mucosa may contract and aggravate the dysphagia by adding a mechanical to the neuro-muscular disorder. In long-standing cases too, as Paterson was the first to point out in 1919, the atrophied tissues may undergo malignant degeneration. This explains why, as Trotter and Waggett independently noted in 1913, 80 per cent. of cases of epithelioma of the post-cricoid part of the pharynx, which always spreads to and obstructs the mouth of the œsophagus,

occur in women, in contrast with carcinoma of the middle and lower end of the œsophagus, of which 80 per cent. occur in men. In a series of papers published between 1929 and 1937 Wassink of Amsterdam referred to the frequency, already noted by Trotter in 1913, with which a long history of dysphagia is obtained in women with epithelioma of the upper end of the œsophagus, and at the same time drew attention to its association with the atrophy of glosso-pharyngeal mucous membrane of *Paterson's syndrome*. Ahlbohm of Stockholm (1936) found that of 153 women with cancer of the buccal cavity and upper end of the œsophagus 99, or 65 per cent., had suffered from anæmia with or without upper dysphagia from five to twenty years before the onset of malignant disease.

The dysphagia itself can be rapidly overcome by the passage of a large mercury bougie on a few occasions before complete recovery results from the taking of iron. The administration of iron in Paterson's syndrome can be regarded as a means of prophylaxis against epithelioma of the mouth of the œsophagus.

The Cardiac Sphincter

A sphincter is a segment of a muscular tube, in which the postural tone of the circular fibres is such that the lumen is completely obliterated and so shuts off the segment above from the segment below. Whereas during activity a muscular tube contracts, generally as a peristaltic wave, its sphincters relax in order to allow the onward passage of its contents. A sphincter has thus a physiological basis, which is not necessarily associated with an anatomical thickening of the circular muscle coat.

In an investigation on the physiology of swallowing carried out with a number of students in 1907 I found that opaque food passes rapidly to the lower end of the œsophagus, where there is a pause, the lower extremity of the shadow tapering to a point which corresponds with the entrance into the cardiac sphincter (Fig. 1). A moment later the food passes on into the stomach, and the shadow of its pointed lower extremity now forms a thin stream, uniform in diameter and averaging about an inch in length, extending to the cardiac orifice of the stomach, the thin stream representing the lumen of the cardiac sphincter, which has relaxed on the arrival of a peristaltic wave at the lower end of the œsophagus. Directly the food enters the stomach the sphincter closes again. This mechanism, which has been confirmed by many observers since 1907, was in fact known to Boerhaave, who wrote in 1766: "The lubricated Aliment is pressed through the slippery œsophagus by the Contraction of its longitudinal and orbicular Fibres; which at last protrude it through the broad Mouth of the Stomach, then open and relax'd,

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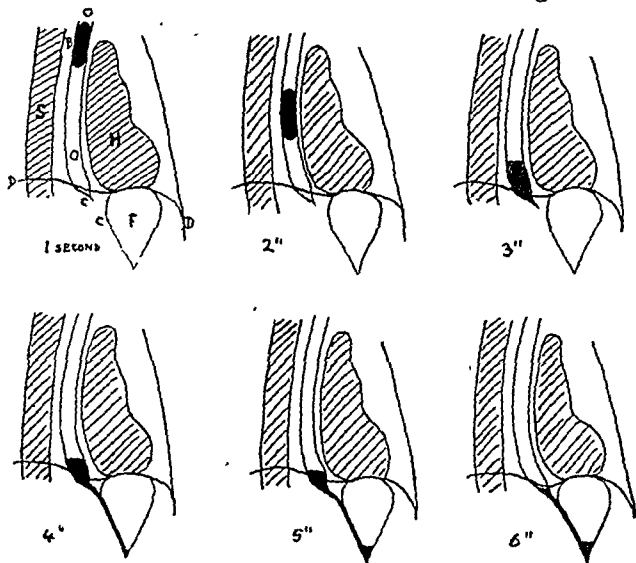


FIG. 1.

Diagrams of the passage of a bolus of barium-containing food (H) through the oesophagus (O—O), as seen with the X-rays in successive seconds after swallowing S, spine; H, heart; DD, diaphragm, CC, cardiac sphincter, F, fundus of stomach.

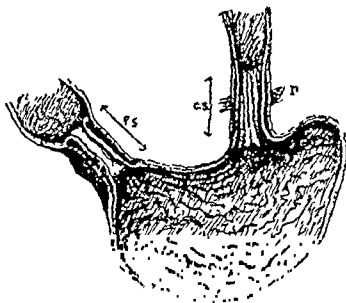


FIG. 2.

Drawing of section through the stomach of a still-born infant. cs, cardiac sphincter with deep, pale, longitudinal rugae and thickened circular muscle. D, diaphragm embracing centre of sphincter. ps, pyloric sphincter.

into its Cavity. The Aliment being thus convey'd into the Stomach the Mouth of the Organ is closed."

Mathew Baillie described an anatomical cardiac sphincter in 1793, but its existence is still often denied. It can, however, be readily demonstrated in still-born infants, in whom the relatively long cardiac sphincter is clearly differentiated from the rest of the œsophagus by the greater thickness of its muscular coat and by the pallor and prominent longitudinal rugae of its mucous membrane (Fig. 2), which remain a constant feature of the radiological picture seen in healthy adults.

So far as the pathogenesis of achalasia of the cardia is concerned, it is immaterial whether the physiological sphincter is associated with an anatomical sphincter. The position of the sphincter can be seen with the X-rays to correspond in most cases with that of the intra-abdominal œsophagus, but it often extends slightly above the diaphragm or begins a short distance below it, and in that form of diaphragmatic hernia which depends on congenital shortening of the œsophagus it is situated entirely within the thorax. Its length varies between $1\frac{1}{2}$ and $4\frac{1}{2}$ cms.

The œsophagus, including the cardiac sphincter, has a double nerve supply—the sympathetic, with its relay station in the extra-spinal ganglia, and the vagus with its relay in the ganglion cells of Auerbach's (myenteric) plexus between the circular and longitudinal muscle coats (Fig. 3). Stimulation of the sympathetic leads to spasm of the sphincter; stimulation of the vagus to relaxation. Division of both vagi prevents the normal relaxation of the sphincter (achalasia) with consequent dilatation of the œsophagus. This is transitory, as the degeneration of the terminal periganglionic fibrils of the vagi does not permanently affect the functional activity of the ganglia.

Achalasia of the Cardiac Sphincter

The commonest nervous disorder of swallowing is achalasia of the cardiac sphincter. The obstruction to which it gives rise results in stagnation of food in the œsophagus, which dilates as more and more food and saliva collect in it. The distension of the œsophagus acts as a powerful stimulus to peristalsis, which becomes very violent and continues at intervals throughout the day. It is, however, completely ineffective and leads to nothing more than churning of the œsophageal contents, as the dilatation prevents the deep waves from cutting off the œsophageal lumen below them from the lumen above, so that no appreciable rise of pressure occurs immediately above the sphincter. The excessive peristalsis is the cause of the muscular hypertrophy which is invariably present.

The obstruction to the onward passage of food at the lower end of the œsophagus, which is felt by the patient and is clearly visible when swallowing is watched with the X-rays, is not associated with any organic

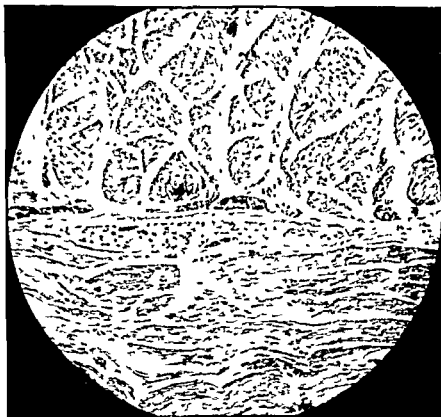


FIG 3

Microphotograph of a normal ganglion of Auerbach's plexus in the lower end of the oesophagus $\times 50$ (G W Rake)



FIG 4

Microphotograph of ganglion of Auerbach's plexus in lower end of oesophagus, showing cell infiltration and degeneration of ganglion cells in achalasia of the cardia with muscular hypertrophy but no dilatation of oesophagus. $\times 50$ (G W Rake)



FIG. 5.

Section through cardiac end of œsophagus in case of achalasia, to show round-cell infiltration (R) and fibrosis (F) of Auerbach's plexus, with complete disappearance of ganglion cells, none being seen in any of 250 serial sections. $\times 50$. (G. W. Rake.)



FIG. 6.

Section through œsophageal wall in achalasia of the cardia in a female of 39 with 16 years' history. It shows fibrous scar occupying the normal site of the plexus. $\times 65$. (G. W. Rake.)

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obstruction At one time it was believed to be the result of cardiospasm, but the complete absence of hypertrophy of the sphincter at autopsy and when examined in the course of a laparotomy, even when it had been present for twenty years or more, shows that this cannot be the cause. Further evidence against cardiospasm is the absence of resistance to the passage of a mercury bougie and of gripping when the bougie is withdrawn, in contrast with the obstruction and gripping observed in anal spasm on introducing a finger. In 1915 I suggested that the obstruction might be the result of absence of the relaxation of the sphincter, which normally occurs when each peristaltic wave conveying food through the oesophagus reaches it. I was at that time unaware that a similar explanation had been independently made in 1888 by Einhorn and in 1896 by Rolleston and, most remarkably, in 1672 by Thomas Willis.

"A strong man, and otherwise healthful enough, labouring for a long time with often vomiting, he was wont, very often, though not always, presently to cast up whatsoever he had eaten. At length the disease having overcome all remedies, he was brought into that condition, that growing hungry he would eat until the *oesophagus* was filled up to the throat, in the meantime nothing sliding down into the ventricle, he cast up raw (or crude) whatsoever he had taken in. When that no medicines could help and he languished away for hunger, and every day was in danger of death, I prepared an instrument for him like a rod, of a whale bone, with a little round button of sponge fixed to the top of it, the sick man having taken down meat and drink into his throat, presently putting this down in the *oesophagus*, he did thrust down into the ventricle its orifice being opened, the food which otherwise would have come back again, and by this means he had daily taken his sustenance for fifteen years and doth yet use the same machine, and is yet alive and well, who would otherwise perish for want of food. Without doubt in this case the mouth of the stomach being always closed by a palsy, nothing could be admitted into the ventricle unless it were violently opened."

I asked Sir Cooper Perry to invent a word for "absence of relaxation"; he proposed *achalasia* from *a*, not, and *χαλασις*, relaxation, and the designation *achalasia* of the cardiac sphincter has now almost universally replaced the incorrect *cardiospasm*.

I believe that *achalasia* of the cardiac sphincter accounts for every case of *megaoesophagus*. In 1924 I suggested that it might prove to be the result of organic disease of Auerbach's (myenteric) plexus. The following year this hypothesis was proved to be correct in an early case with hypertrophy but no dilatation by my house physician, G. W. Rake (1926) (Fig. 4), who subsequently found inflammatory (Fig. 5) or degenerative changes (Fig. 6) in the plexus in all of the eleven specimens he was able to collect (Hurst and Rake, 1930). Similar changes in the plexus have been demonstrated in every one of forty-one other cases in which

it has been examined (Cameron, 8 ; Mosher and McGregor, 1 ; Beattie, 1 ; Rieder, 2 ; Etzel, 16 ; Lendrum, 13). Etzel (1937) and Lendrum (1937) have shown that the *vagus* itself is not affected, the lesion being confined to the ganglion cells, which form a relay station for the *vagus* on its way to the muscle fibres of the *œsophagus*. The number of ganglia was always much diminished, and frequently none could be found. In some cases there was evidence of active inflammation, in others of fibrosis, and in others simply atrophy.

The weight of the column of food in the dilated *œsophagus* after a meal is sufficient to force a small proportion of the fluid present through the sphincter as a narrow stream. But as soon as the height of the column falls below a certain point, generally about seven inches, or the individual lies down, the pressure becomes insufficient and the flow

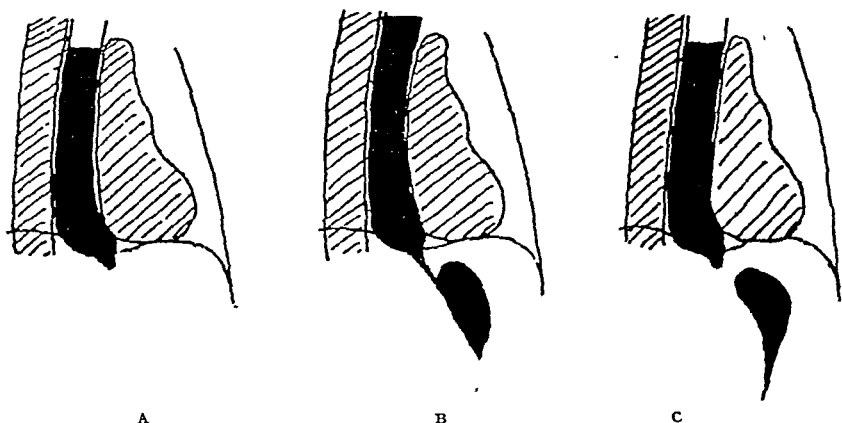


FIG. 7.

Diagrams of *œsophagus* in achalasia of the cardia. A shows column of barium-containing food, 7 in. high above closed cardia. B, after additional quantity of food swallowed, so that the taller column, being heavier, opens sphincter and allows surplus to enter stomach. C, return to condition of (A) after surplus food over the 7 in. column has entered stomach.

Note absence of gas bubble from fundus of stomach.

ceases (Fig. 7). Consequently, stagnating food mixed with mucus is always present in the *œsophagus* (Fig. 8), and a considerable quantity can be expelled from it even after a fast of twenty-four hours, either voluntarily by the patient or on aspiration through a tube. Regurgitation rarely occurs on lying down, as the pharyngo-*œsophageal* sphincter remains closed (Fig. 9), as in normal people, except during the act of swallowing.

Two old theories to account for the obstruction at the cardia have been recently mentioned by Negus and require consideration. Jackson believed that the obstruction was a result of spasm of the muscle bundles of the diaphragm which encircle the *œsophagus* at the hiatus. But Feldman and Morrison (1934) have shown that the sphincter action of the lower end of



FIG 8

Radiograph of enormous S-shaped megaesophagus taken after evacuation of oesophagus so that barium emulsion should fill it entirely. Horizontal upper surface eight inches above closed cardiac sphincter with gas bubble over it is thus clearly seen.



FIG 9

Same case as Fig 8, taken in horizontal position, showing closed upper sphincter of oesophagus preventing regurgitation into pharynx.

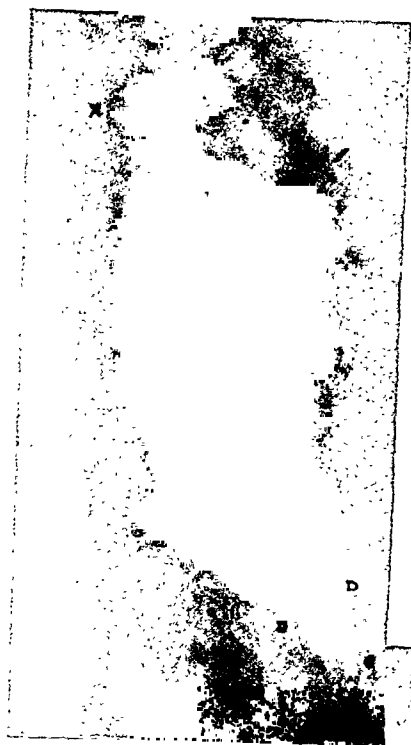


FIG. 10 (a).

Radiograph by Dr. Lindsay Locke, showing the dilated œsophagus, filled with opaque meal. xx, upper surface of column of fluid supported by the closed cardiac; dd, narrowing of dilated œsophagus caused by unyielding fibrous tissue, where it passes through the diaphragm.



FIG. 10 (b).

Radiograph by Dr. Lindsay Locke, taken directly after Fig. 10 (a), showing the mercury tube, mm, passing through the cardia into the stomach.

Nervous Disorders of Swallowing

the œsophagus in dogs is unaffected by bilateral phrenicectomy. Moreover the dilatation of the œsophagus often extends below the diaphragm into the abdomen (Fig 10 (a)), and I have also seen it associated with a congenitally short œsophagus, when it ends in the thorax well above the diaphragm. These facts are also sufficient to refute Mosher's theory that the obstruction is in some way dependent upon an abnormal position of the œsophageal groove in the liver, especially when subjected to pressure from the left by excess of gas in the stomach. Mosher had moreover failed to notice that achalasia of the cardia is the one condition in which no gas bubble is ever present in the fundus of the stomach. This is due to the fact that the œsophagus is always filled with a mixture of food and saliva, which acts as a lock and so prevents aerophagy, the sole source of the gas normally present in the stomach.

Treatment—The simplest and most effective treatment is by means of mercury bougies, which I first devised in 1913. They are made of rubber tubes, 31 inches long and from 24 to 34 gauge. They are closed at the top and have a rounded lower end, each contains the same weight (1 lb 5 oz) of mercury. Three or four of increasing size can generally be passed at the first sitting. On a subsequent occasion a bougie should be passed with the guidance of the X-rays (Fig 10 (b)), and a mark made to show the position of the teeth when its lower end is in the right position—about two inches below the cardiac orifice. The largest which the patient can himself pass should be chosen, this is generally No 34 ($\frac{3}{4}$ inch diameter). It drops easily through the sphincter and requires no pushing. It is kept in position for a quarter of an hour on each occasion. The patient feels relieved and realizes that the passage is clear as soon as it is withdrawn. It should be passed immediately before meals, the food which should be well masticated, is then felt by the patient and seen with the X-rays to enter the stomach without difficulty. I once saw a man of 70 two hours after breakfast, when his food had stuck for the first time. After confirming the diagnosis with the X-rays, I passed a mercury bougie, this resulted in an immediate and permanent cure. Generally, however, the tube has at first to be passed before the three chief meals for about a fortnight, then once a day for a fortnight, and then gradually less often, till finally it is no longer required or is used only at rare intervals when the patient feels that some slight obstruction is returning. In chronic cases, which are always associated with secondary œsophagitis, the diet for the first two or three weeks of treatment should consist of nothing but a pint of milk with the addition perhaps of a beaten up egg or glucose and fruit juice, taken three times a day immediately after the passage of the bougie. Half a pint of water should be drunk ten minutes later in order to cleanse the redundant œsophageal mucosa, and water should still be drunk after each meal when the bougie is no longer used.

The attempt to relieve achalasia of the cardia by division of its sympathetic nerve supply by resection of the left gastric artery proved unsuccessful in spite of early reports to the contrary (Knight, 1935), as the condition is not a result of spasm caused by over-activity of the sympathetic but of achalasia caused by vagal paralysis. Telford, having obtained good results in the treatment of the megacolon resulting from anal achalasia in children by spinal anæsthesia, attempted to relieve achalasia of the cardia by a spinal anæsthetic to include the first dorsal nerve so as to paralyse the whole of the sympathetic outflow from the spinal cord. Though his first patient gained symptomatic relief, which is still maintained after four years, and another remains well after three years, nine further cases showed no improvement (Telford, 1942). Perhaps the relief gained in the two cases is of the same nature as that experienced by a patient of Ryle's, who claimed to have been cured by "laying on of hands" by a faith-healer, although the X-rays showed that the obstruction at the cardia was as complete as ever. As a result of suggestion the unpleasant sensory response of the œsophagus to distension is lost, this "hysterical" addition to the clinical picture having the curious result of leading to the disappearance of symptoms instead of the development of new ones.

The dilatation of the œsophagus in achalasia of the cardia manifests itself in an increase in length as well as in diameter. As the upper and lower extremities of the œsophagus are fixed points this may in very chronic cases be sufficient to produce a sigmoid curve of the lower end, the most dependent part of which rests on the diaphragm to the right of and behind the cardia. From here it ascends to the left and enters the abdomen through the diaphragm with the formation of a reservoir below the level of the cardia. It is then impossible for a mercury bougie to gain access to the sphincter, which should be stretched by the introduction successively of one, two, three and four fingers through an opening made in the stomach after laparotomy. This treatment is not without danger, as the thin walled sphincter may be split and fatal mediastinitis or peritonitis develop, and I have seen several cases in which temporary improvement was followed by a recurrence of dysphagia owing to the development of a fibrous stricture, sometimes only after several years. As with the exception of the very rare cases in which severe kinking prevents the passage of a mercury bougie, the correct use of a bougie of sufficient size invariably gives complete or almost complete relief without the slightest risk, the routine treatment by digital dilatation, as recommended by Walton (1942), is quite unjustifiable.

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SOCIETIES' PROCEEDINGS
ROYAL SOCIETY OF MEDICINE—SECTION OF
LARYNGOLOGY

Friday, November 6th, 1942

President—V. E. NEGUS, M.S.

The Mechanism of Swallowing

THE President's Address is published in this issue of the *Journal of Laryngology and Otology*, Vol. LVIII, No. 2, pp. 46-59.

DISCUSSION

Sir JAMES WALTON said the President's description of how in man there had developed the separation of the respiratory and swallowing functions had interested him for it was a general experience that when a person was suffering from a bad cold and the upper nasal tract was obliterated he was out of breath when eating. This was not the case under normal conditions, and he wondered whether the separation was complete. The fact that a man could hang upside down without vomiting made him also doubt the complete absence of a cardiac sphincter.

In man two factors were present in swallowing, namely, peristalsis and gravity. Peristalsis could act alone in man, as it could in the giraffe. When young they had probably all lain on a river bank and drunk with their heads down to the stream, so that gravity did not act at all. In cardiospasm peristaltic waves were, in the later stages, incapable of overcoming the obstruction at the cardia and gravity became an important factor.

All persons had the power of relaxing their œsophagus, some more than others. He had watched with astonishment how some men would take up a jug of beer and let it slide down their œsophagus. He did not agree, however, concerning the absence of regurgitation. He had always taught that one of the most definite symptoms of the presence of cardiospasm was that the patient would tend to get regurgitation when asleep.

He had always been interested in the question of the sphincteric action at the lower end of the œsophagus. It was assumed that there could be no spasm of the sphincter because there was no hypertrophy, but there was no evidence that spasm of an involuntary muscle in any part of the body ever produced hypertrophy. Congenital pyloric stenosis was not due to a spasm; it was due to a congenital abnormality in which there was hypertrophy of the muscle even before birth. The mere absence of hypertrophy was not an

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indication that there was no spasm. His own clinical experience was entirely in disagreement with that of Sir Arthur Hurst. In all the cases of cardiospasm—nearly 50—on which he had operated he had been able to demonstrate by passing a bougie the evidence of spasm at the lower end. Sir Arthur Hurst laid it down that failure of relaxation of the sphincter was due to atrophy of Auerbach's plexus, but he was more and more convinced that cardiospasm was a congenital fault. It was true that most of the cases were seen between the ages of 50 and 60, but they might have had it in a latent form throughout life. The youngest case he had come across—a typical cardiospasm as shown by the X-ray appearances—was in a child under 2 years of age. Therefore he must assume that it was a congenital fault, and that the degeneration of Auerbach's plexus was a secondary factor.

As for treatment, here it was only fair to say that a surgeon's view and a physician's view must be different. Of necessity he, a surgeon, saw the physician's failures, and the physician saw his, and therefore the disease was seen from rather a different angle. But he had never been convinced of the value of the passage of the mercury bougie. He had known cases in which the mercury tube had been passed, but the patient had had little or no relief, and he had seen many cases which had been treated by physicians who were advocates of the passage of the bougie, and its use had not led to a satisfactory result. In his own cases he had opened the stomach and dilated the cardiac sphincter. Care had to be taken lest by slight over-stretching the œsophagus might be torn, and that was almost always a disaster. Therefore the dilatation should not be done by an instrument but digitally. He practised the insertion of first one finger, then a second, and a third and a fourth. He aimed at getting the four fingers in, but it should be done with the fingers only. He had had no experience of the operation which Mr. Grey Turner supported, namely, anastomosis between the dilated and S-shaped œsophagus and the fundus of the stomach, but he believed that the majority of these patients required operative treatment.

E. D. D. DAVIS said that during twenty-five years he had œsophagoscoped more than 50 cases of so-called cardiospasm, but he had records of 36 only, and out of these he was able to show to the meeting a few X-ray photographs. They illustrated the intricate mechanism of the cardiac end of the œsophagus. There was a definite constriction as the opaque medium went through the diaphragm at the hiatus and the gullet bent forwards to the left. Often the œsophagus at the hiatus was mistaken for the cardiac sphincter. There was a good specimen at the Royal College of Surgeons showing the projection of the lower end of the œsophagus into the stomach. That was not shown in the ordinary post-mortem examination because the œsophagus and stomach were pulled out. He believed that dilatation in the œsophagus and the so-called cardiospasm and achalasia were a congenital neuromuscular disorder of the œsophagus. He had dilated with a bougie and had found a great variation in the ability to swallow. For months the patients would be perfectly well, and then they would have difficulty in swallowing and ask to be dilated. One man, aged 74, had had difficulty in swallowing all his life. The youngest case he had was a child of 10 years, but the condition had been seen in children under 4. He believed that Parkes Weber had collected eleven cases under

the age of 7. In some cases the mercury tube was of no value, and he agreed with Sir James Walton that the proper procedure then was to open the stomach and dilate the cardiac sphincter, the earlier the better.

P. R. ALLISON said that one of the great difficulties in investigating the question of pressures in the œsophagus was that as soon as the œsophagoscope was passed the pharyngeal sphincter was opened and all the observations were null and void. But if after operation on the œsophagus for a carcinoma the upper end of it were brought out of the chest wall, an admirable opportunity was afforded for measuring the sort of pressures which were obtained on swallowing. To illustrate the force of swallowing he mentioned the case of one patient from whom he had removed the œsophagus, afterwards placing him flat on the table, putting in a tube and connecting it with a vertical glass tube. At the first swallow of water the patient pushed the water in the glass tube up to 12 in., and maintained it there; at the second swallow he pushed it up to 24 in., and still there was no regurgitation. At the third swallow it went up another 6 in. and then regurgitation occurred. Therefore by the force of swallowing alone a column of water $2\frac{1}{2}$ ft. could be maintained. It was quite easy to see why a man could swallow while standing on his head, without peristalsis and without gravity. When a plastic operation was done the terrific pressure involved during the act of deglutition was demonstrable.

A. S. JOHNSTONE showed some radiograms illustrating the mechanism of swallowing to explain an unusual cause of dysphagia. The barium meal in its passage was observed and the overturning of the epiglottis clearly illustrated. His explanation was that the hyoid bone was raised upwards and forwards and the thyroid cartilage came well up into it. This caused the pad of fat at the base of the epiglottis to bulge backwards to meet the closing arytenoids. A fulcrum was made at this point and the base of the tongue rolled the base of the epiglottis over. The rest of the movement was carried on by the small intrinsic muscles. If several swallows were made without respiratory interruption the epiglottis remained overturned. When the act was completed the hyoid bone and thyroid cartilage dropped back and the base of the epiglottis returned to its normal position, the tip sliding up the posterior pharyngeal wall to flick back into the upright position. The restoration was completed by the recoil of the elastic tissue. In a number of cases the return of the epiglottis was so slow that it caused the sensation of something sticking in the throat. This occurred generally in elderly patients and was probably due to senescence in the elastic cartilage. These were the individuals who might develop cancer-phobia, complaining of something sticking in their throat and constantly seeking advice, only to be told that there was *nothing abnormal*.

WALTER HOWARTH said he was quite sure there was no real cardiac sphincter. He had made many dissections of the lower end of the œsophagus with the late Professor Shattock; and it was quite impossible to prove the existence of any anatomical sphincter.

J. C. HOGG said the point with regard to the treatment of cardiospasm or achalasia was that all the various procedures would do good in the appropriate case. Some cases would respond easily, others would require more radical treatment. No mention had been made so far of dilatation with the hydrostatic bag as a favourable method in this condition. Sir James Walton took

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the view that it was dangerous to use a form of instrumental dilatation With the greatest respect he joined issue with him on that point To his own way of thinking there was as much precision in dilatation with a rubber bag filled with water or air as with the finger He could not admit that the risk of rupture of the œsophagus was any greater—indeed he would consider it was less—with the bag than with the fingers There might be severe cases which did not respond to that treatment, but he was satisfied that the average severe case would do so

OBITUARY

SIR STCLAIR THOMSON

THE death of Sir StClair Thomson in Edinburgh on January 29th, at the age of 83, conveys something more than the sense of loss which all must feel at the passing of a distinguished man in the fullness of his years and honours, for it brings to a close an era in British Laryngology which began about eighty years ago with the initial effort of Morell Mackenzie Amongst those who followed close upon him and established Laryngology as a reputable branch of medicine in Great Britain, StClair Thomson was for years the acknowledged leader and master, and herein was perhaps his greatest service Although he was born in Londonderry, his father was a native of Ardrishaig, in Argyllshire, but Scotland seemed to have little attraction for him until, as often happens he returned to the country of his boyhood towards the close of his life This was perhaps due to the manner of his education, for after leaving the King's School at Peterborough, he did not go to the University of Edinburgh but followed Lister to London and became his house surgeon at King's College Hospital This association exercised a lifelong influence over Thomson's work and outlook and its effects could be observed in his clinical methods the careful though not over-elaborate study of each case, the caution in arriving at a diagnosis, the complete records and also in the scrupulous care exercised in his preparations and operative technique

Travel with a wealthy invalid occupied a couple of years after qualification and then followed practice for seven or eight years in Florence, combined with practice at St Moritz during the season For this Thomson took the Swiss Federal Diploma at Lausanne It was at the end of this period that he began the study of Laryngology in Vienna, Hajek, to whom he was always grateful being one of his chief instructors and he also studied in the aural clinic of Politzer * He was elected to the staff of King's College Hospital in 1901 and shortly afterwards developed the tuberculosis of lung and larynx from which he made such a remarkable recovery This played a part in the deep interest which he took in that disease and led up to his devotion to King Edward's Sanatorium at Midhurst, his Mitchell Lecture at the Royal College of Physicians and the monograph for the Medical Research Council which were based on the work at Midhurst and also to his continuous support of the Tuberculosis Association His other great special interest was developed from his admiration for the work of Butlin and Semon on Cancer of the Larynx He improved the

Obituary

technique of their operation of thyrotomy for limited cancers of the vocal cords and published careful records of his cases. Although these were not very numerous, for the disease is not a very common manifestation of cancer, and those of Butlin and Semon were much less so, he realized the value of thorough study of a small series of cases and he deplored the recent tendency to break away from the methods which he developed into laryngo-fissure and gave such successful results in his hands. His principal writing was the well-known textbook which passed through four editions besides a number of reprintings and in keeping this abreast of rapid changes he took great pride. Another early book on the escape of cerebro-spinal fluid from the nose is probably not much read nowadays, but it is a model of how a small monograph should be put together. In spite of all this industry, which by itself would have brought fame, his personal influence, his numerous friendships with the leaders of the profession all over the continent and in America, his carefully prepared hospitality and his genius for spreading encouragement and goodwill amongst the younger laryngologists were more potent factors in carrying him to the commanding position which he occupied in the profession. He became President of the Royal Society of Medicine and of the Medical Society of London, unusual distinctions for a specialist. At the Royal Society of Medicine, in addition to being President of the Laryngological Section, he also held office as President of the Section of History of Medicine, in which he took an interest that showed itself in much of the pottery, pharmaceutical jars and other decorative objects which he liked to exhibit in his house, where, too, his magnificent collection of coloured prints depicting scenes from Shakespeare reflected his knowledge of those plays from which he could quote aptly for any occasion. Residence abroad had given him the command of several languages and he had a natural aptitude for speaking in public which he cultivated most carefully, so that he made himself one of those rare people who can both write and speak supremely well, and was the outstanding personality in any company.

It was, however, the character behind all these gifts, the gentle wisdom, the unflinching gaiety and humour which gained and retained for him to the end the love, admiration and respect of all who had the privilege of his friendship.

LETTER TO THE EDITOR

TO THE EDITOR,

The Journal of Laryngology and Otology

DEAR SIR,—I shall feel obliged if you will publish an addendum to rectify a description which is faulty owing to an error in the transmission of the MS of a contribution which I made to the December Number of the *Journal*

The passage is a reply to the contention that the hair cells cannot be the agents concerned in the generation of electric potential in the vicinity of the cochlea, at a distance from the auditory tract, in response to sound waves, because it is fully developed before there is any potential in the tract, and this is generally considered as the evidence of activity of the cells

During the arrival of sound waves of the same frequency pressure is periodically raised at the fenestra rotunda, fluid is forced along the scala tympani, and the pressure is raised on the lower surface of the basilar membrane. As these changes are initiated the segment of the membrane, resonating with the frequency, is at its lowest point and subject to maximum tension. The recoil is, therefore, upwards and accelerates the movement of fluid into the corresponding segment of the scala, and provides for its retention. It also forcibly draws the fluid outwards and upwards across the outer wall, accentuating its natural tendency to move in this direction under the influence of centrifugal force. In all segments between it and the fenestra there is also an increase in fluid and in pressure, but in each of these the membrane offers a resistance which constrains the movement to a circular path, and the recoil is in a downward direction and reverses the movement of the fluid upwards and outwards. Thus in these segments the resistance and the recoil, together, transmit both the increase in fluid and in pressure towards the segment with the resonant membrane.

In general terms the force of the recoil in the resonating segment may be said to be expended in accelerating the movements of the fluid on the opposed surfaces of the membrane in reverse directions, namely, from and to the respective fenestra, and the momentum which the fluid thus acquires is expended in increasing the displacement and, consequently, the tension of the membrane and the force of the subsequent recoil.

When, however, the first impulse of the series reached the cochlea the recoil was absent. The membrane in consonance with the frequency was not resonating, it was in the neutral position and offered resistance to displacement directly in proportion to the tension created by it, and the increase in fluid and in pressure were transmitted, to that extent, to those parts of the scala farther from the fenestra in which the resistance to displacement became progressively less.

The mechanism is ideal for concentrating the force generated by a series of waves on the consonant segment of the basilar membrane, and for increasing

Letter to the Editor

the concentration during *each phase* of a wave till an optimum result is obtained. But throughout the process the force of the impulses and the consequent total displacement of the membrane, the total distortion of the hair cells, and the total potential created, probably remain substantially constant ; the decrease in the movements of other parts of the membrane compensating for the increase in the consonant segment.

Clearly physiological considerations require that the segment, and only the segment, psychologically associated with the frequency should be displaced sufficiently to excite an impulse in the auditory tract.

The tract potential, or response, would be delayed till the force of the impulses had been sufficiently concentrated on the consonant segment to give this result ; whereas the lesser distortion of the cells in the resonating segment by the initial impulse, augmented by the greater distortion of those in other segments, would generate a potential which would give a cochlear, but not a tract, response.

H. MACNAUGHTON-JONES

The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

March 1943

ON RHINOLITHS

By CYRIL JOHN POLSON (Leeds)

ADDITIONAL reviews of the literature concerning rhinoliths appear superfluous when those by Demarquay, Seeligmann, Seifert, Hérisset and Key-Åberg are recalled. Twenty years have elapsed, however, since publication of the latter's review, and recent papers have at times included generalizations which are not in accord with former conclusions; it seems opportune, therefore, to re-examine the evidence.

The preparation of a complete bibliography proved impracticable, since a number of reports are in journals which are inaccessible. Opportunity to study the lesion at first hand has, as yet, to occur, despite a growing collection of nasal material.* An abundance of evidence, however, has been published, and the present review is based upon verified reports, many well furnished with detail, of 257 rhinoliths, amplified by limited information concerning a further 127 cases.

Historical and Bibliographical Observations

Despite their rarity or, perhaps, because of it, rhinoliths have attracted considerable attention. During the sixty years between 1880-1940, for example (with the exception of 1920), at least one new case was reported each year. The majority are isolated case reports since opportunity to collect even a small series is rare. Morell Mackenzie described but two patients; Lantin and Joukovsky each had four, and Garel, Chiari and Guttmann each had five cases. There were five cases at Moure's clinic, of which three were described by Moure and two by Monnié. The review by Key-Åberg includes an account of eleven rhinoliths, but only four are accompanied by clinical details, and, of these, one is a republication, with added details, of Holmgren's case. The largest individual series yet recorded appears to be the seven cases described by Graaf (1932).

* See Addendum, p. 116, for Pavey-Smith's case

Cyril John Polson

Mathias di Gardi, 1502, is frequently stated to have given the first account of a rhinolith, but Demarquay, probably the only author to have read the original text, excluded it from his collection of fifteen reports. It appears that di Gardi merely mentioned that a colleague had seen a rhinolith, as big as a pine cone, expelled by a patient. The earliest reports, therefore, are those of Bartholin, 1654, one of which is the first rhinolith with a cherry stone nucleus. An antral rhinolith was described anonymously in 1686, the report being frequently credited to Lanzoni (1738); it would appear that Lanzoni merely republished the earlier report. Oppikofer compared the two Latin texts, which are reprinted in his paper, and, after demonstrating their similarity, concluded that "Aus allen diesen Gründen sind wir berechtigt die Beobachtung von Lanzoni anzuweifeln".

Although the conclusions in Demarquay's review may now be obsolete, it remains, as Mackenzie predicted, the principal source of information concerning the early cases. Demarquay's abstracts were apparently reprinted by Monnié and, in turn, by Didsbury. The bibliography which accompanies Seeligmann's dissertation was republished with a few amendments and additions by Hall, but, being of earlier date, it is less useful than that compiled by Hérisset. Seifert's review, in Heymann's Handbuch, is perhaps the best known but it is mainly an indigestible and not always accurate compilation of facts and authors' names. The bibliography is almost exhaustive but Key-Åberg was able to amplify it, notably in respect of certain rhinoliths which contained cherry stones. Key-Åberg's review is comprehensive and supported by an account of eleven rhinoliths.

Information concerning rhinoliths described by Russian authors is largely inaccessible but some account of them is given by Joukovsky.

Antral rhinoliths, which still appear to be limited to only six authentic cases, were reviewed by Oppikofer, whose report of the fifth is, as yet, the most comprehensive description of one of these stones.

The term rhinolith, "*mot que ne préjuge rien sur leur nature*", is ascribed by Demarquay to Graafe, who also formulated, on slender evidence, the theory that rhinoliths are a manifestation of gout. Demarquay's criticism should have proved sufficient, for all time, to demonstrate its futility. Only one other patient, who suffered coincidentally from gout and a rhinolith, appears to have been described (Curtis). Cozzolino is said to have first made the distinction between "true" and "false" rhinoliths (Didsbury, Trimarchi).

The Incidence of Rhinoliths

Collected cases, totalling fifteen in 1845 (Demarquay), were increased to 110 by Seeligmann (1892), and to about 300 by Key-Åberg (1921-22). During 1910-25, a period which slightly overlaps that covered by

On Rhinoliths

Key-Åberg, there were 49 reports (Bailey), 14 more during 1925-33 (Morwitz), and another 7 during 1933-36 (Snyder and Feldman). Reports by Tsugawa (1937), Kravchenko (1938), Bleicher (1939, two cases), Costen (1939), Bomfim (1940), Hutcheon (1941), Arauz and Belou (1941) and Goodyear (1942) have since appeared. No mention is made by Snyder and Feldman in their text or references of the reports by Ito (1935), Bergstrand (1936, four cases, of which only one is a detailed report), Tessier (1936, two cases), and Enokov (1936). It is thus seen that to date about 387 rhinoliths have been described.

The present search yielded information concerning 384 rhinoliths. If the 111 other authors, who appear to have written about rhinoliths, but whose references are inaccessible or inadequate, be credited with one case apiece, the total on record, by this mode of estimation, is about 495.

It is often stated that children frequently insert foreign bodies into their own, or other children's noses. Keen (1930) has shown, however, that there were only 30 nasal foreign bodies amongst 15,000 children, and 16 of the patients were promptly cured at their first visit. If this is a representative observation, as it seems to be, it is not surprising that rhinoliths are rare. The introduction of medical inspection of school children and an increase in the general standard of education are also factors calculated at least to prevent an increase, if not to cause a reduction, in the incidence of rhinoliths.

Definition

A rhinolith is the result of complete, or partial, incrustation of an intra-nasal foreign body, usually of exogenous, but occasionally of endogenous origin. The term is also used to include similar concretions found but rarely in the antra and nasopharynx. Exogenous foreign bodies include objects like fruit stones, particularly cherry stones, buttons, or paper; endogenous foreign bodies include dried blood clot, misplaced teeth, sequestra and, perhaps, dried nasal secretion. Incrustation is, in the main, by phosphate and carbonate of calcium, derived largely from the products of inflammation.

Sex Incidence

A preponderance of females was first noted by Seeligmann, who found that amongst 110 patients, 62 were females and 29 males. Seifert and Hérisset believed the sexes were equally affected, but Key-Åberg confirmed the earlier observation when he found that 73 per cent of the patients were females. The limited scope of their investigation, in the main of records of only 16 patients, probably led Snyder and Feldman (1936) to the conclusion that males were in the majority. The present survey finds that of 257 patients 146, or 56.8%, were females, and 95,

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or 37%, were males; the sex of 16, or 6.2%, was not stated. The greater frequency of rhinoliths in females is deemed significant, but no satisfactory explanation is offered. Seeligmann thought that it was accounted for by the fact that women blow their noses less frequently and less violently than men.

Age Incidence

Rhinoliths have been found in patients whose ages ranged between 3 and 76 years. Snyder and Feldman were by no means the first to record a rhinolith in a young patient, nor is their boy aged 6 years the youngest on record. Two boys, aged respectively 3 and 4 years, were described by Czarda, the youngest patients in the present series. There were reports, also, by Ball, Beach, Harrel and Hinde, of patients, aged respectively 4, 4, 5 and 5 years, and Key-Åberg's personal case was a boy aged 6 years. Only three patients were over 70; that of Calamida was 76, that of Hérisset and Ripault 74, and Keleman described one aged 73 years.

When grouped according to decade, the case incidence was: 1st, 15; 2nd, 44; 3rd, 47; 4th, 34; 5th, 38; 6th, 19; 7th, 16; and 8th, 3 cases. The ages of the remaining 41 patients were not stated. A maximum incidence occurred in the third decade, accompanied by a high incidence also in the second, fourth and fifth decades. The factors of latency, self-neglect and, at times, of erroneous diagnosis, contributed to load the later decades, for it must be recalled that these ages correspond with the time at which the rhinoliths were discovered.

The "danger" period for the entry of nasal foreign bodies was believed by Bross and Molinié to be during the first five years of life, but Key-Åberg thought this too narrow and preferred to extend it to the first decade. Undoubtedly the majority of foreign bodies, which were ultimately incrustated, entered the nose during childhood, as happened in 83% of cases reviewed by Key-Åberg. This is confirmed by the present enquiry. The clinical histories of 139 patients showed that entry during the first decade was unquestionable in 46 and a strong probability in 44 patients, i.e. 65%, with another 26 cases, or 19%, where entry during infancy was a possibility. By contrast, entry during adult life was certain or a possibility in only 23 cases, or 16%. This enquiry, however, supports Bross and Molinié rather than Key-Åberg in that the majority of children, who acquired foreign bodies, were then aged 5 years or less; only 6 of the 46 children, in whom there was an unequivocal history, were over 5 years old, at the time of entry of the foreign body. The adult group of 23 cases included two snuff takers (Böhm, Ruault); two incrustated teeth (Wepfer, Wright, J.); two "industrial" cases (cement, Smith, L. W.; felt, Ireland); three due to accident or operation (Mascarel, Krebs, and Snyder and Feldman); and only two of insertion of foreign

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bodies by adults (Tillaux and Crabbe) ; in at least another eight there is doubt whether the foreign body did, in fact, enter during adult life, as in the cases of Barraud, Baumgarten, Brown, Miller, Rebattu, Rohrer, Ruault, and Schiffers.

As Key-Åberg has observed, it is impossible to determine, on clinical evidence, the precise time necessary for complete incrustation. There are, however, a few reports which give an approximate estimate of this period. Tillaux's patient had inserted a cherry stone into her nose about three years before it was recovered as a rhinolith ; the interval in the patients described by Paterson and by Beach was about $4\frac{3}{4}$ and $2\frac{1}{2}$ years, respectively. Other rhinoliths, for example those recovered by Czarda and Gerber, by virtue of the age of the patient at the time, i.e. 4 and 7 years, and the clinical history, must have developed in from 2 to 5 years. The latter specimens measured $13 \times 10 \times 7$ mm. and $20 \times 10-15$ mm., which suggests that at the end of about three or four years a rhinolith is likely to be only of relatively small size. Articles suspended in water from the " Dropping Well " at Knaresborough, water rich in lime salts, become " petrified " in from three months to two years, according to their size and texture. Although the circumstances are not precisely similar, this gives some idea of how long incrustation may take.

Pathological Anatomy

Rhinoliths are almost always single and unilateral. The right and left nasal fossae are involved with about equal frequency, a slight excess, probably of no significance, being noted on the right side. Amongst 257 verified cases, 104 rhinoliths were on the right and 96 on the left side ; 4 were present in the nasopharynx, 3 in a maxillary antrum, and in 3 patients rhinoliths were bilateral ; the site of another 47 was not stated.

Multiple stones were thought to exist in nine patients, other than those with bilateral stones. The specimens of Mackenzie, Jones, and possibly Cozzolino are the only likely examples, for in all the others, multiplicity is believed to have been due probably to the passage of fragments detached from a larger stone. Confirmation of multiplicity, by the demonstration of separate nuclei, has been afforded only in respect of bilateral rhinoliths. Mackenzie believed the fragments removed from one of his patients were probably, he made no stronger claim, parts of two stones, one of which measured 15×8 mm, and the other smaller. Jones's case was somewhat similar. Axmann's patient expelled several small stones, at intervals, over lengthy periods. Sneezing usually preceded the event, suggesting that they had been detached by its violence from a larger stone. Similar stones, of lentil size, were removed by Blandin from his patient (Demarquay). Nélaton removed a rhinolith the size of a pea from the nose of a young man and other stones, somewhat

larger, were then expelled spontaneously (Rouyer) ; the circumstances of Allen's second patient were somewhat similar. Multiple stones were also described by Kern and Reverdin.

The case of bilateral rhinoliths, described by Nitsche, was accepted by Seifert with some hesitation as the then unique instance. Hopmann's patient had had a brief illness, with vomiting as a principal symptom. When examined thirty years later, both nasal fossae were filled with polypi ; these were removed without relief, and, subsequently, two rhinoliths were found in the left, and a third in the right, nasal fossae. They probably originated during the earlier illness when cherry stones, as in Nitsche's patient, gained the nose. Birman-Bera (1931-32) briefly described another instance of bilateral rhinoliths, the nuclei of which were not mentioned.

Rhinoliths are uncommon in the nasopharynx. Birkett's patient "swallowed" a thimble, when aged 5 years. Nasal catarrh commenced a year later, and persisted until she was 23, when an incrustated tailor's thimble was removed from her nasopharynx. An incrustated metal regulator, part of an infant's feeding bottle, was removed by Paterson from the nasopharynx of a boy aged 6 years. When this patient was a baby of 15 months he had had an abrupt attack of dyspnoea, which was treated by inversion. The attack subsided, but thereafter nasal obstruction was persistent. Janatka removed a large rhinolith from the nasopharynx of a boy aged 9 years ; this stone had obstructed both Eustachian tubes and predisposed to bilateral otitis media. Mr. E. W. Bain told me of a rhinolith, containing a signet ring, which he had removed from the nasopharynx of a patient ; the ring was lost 50 years previously. Foreign bodies, apparently free from incrustation, were found in the nasopharynx by Hickman, who removed a steel ring which had been impacted there for 13½ years, also by Lowndes, who removed a small brass ring, and by Milligan (1898), whose specimen was a red clay marble.

Oppikofer found the authentic records of only four antral rhinoliths, namely the anonymous report of 1686, republished by Lanzoni (1738), and those by Zuckerkandl (1892), Harke (1895), and Kahnity (1902). The fifth case (Oppikofer, 1908), concerned a doctor's widow, aged 60, who had had nasal trouble for some 20 years. Her principal complaint was an intermittent, unilateral, purulent nasal discharge. A rhinolith, the size of a hazel nut, 12 × 12 mm., weighing 0.98 gm., was found in the right antrum. Its chemical composition resembled that of nasal rhinoliths : water 1.66%, organic matter 11.91%, calcium oxide 40.72%, phosphorous pentoxide 40.52%, and magnesium oxide 3.81% ; no nucleus was found. The stones described by Zuckerkandl, Harke and Kahnity were all of about hazel nut size. A sixth case, described by A. J. Wright in 1927, is the only one published since Oppikofer's review. This rhinolith contained the root of a molar tooth, displaced into the right

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antrum during extraction many years previously. Sinusitis of the antrum and frontal sinus was now present. After two operations to drain the sinuses, the stone was expelled spontaneously, gaining the nose through an opening in the antral wall made at operation several months previously. The rhinolith was approximately spherical and about 15 mm. in diameter; no analysis was made. Oppikofer failed to find any record of a rhinolith in any of the other nasal sinuses, and none has now been found. Non-incrusted foreign bodies, however, have been removed, not only from the antra, but also the frontal, sphenoid and ethmoid sinuses.

Lachrymal calculi are outside the present discussion, but their nasal association may permit a brief comment. Phillips and Cunier (1842) described a case and distinguished this kind of stone from rhinoliths. They mentioned that only four other cases had been reported up to that time, but several, e.g. by Mounier and Onodi, have since been described. Bleicher had an interesting example of fictitious lachrymal calculi. A girl, aged 13, had for five years been troubled with a blackish secretion round the right internal palpebral angle and at intervals minute concretions, of 1-2 mm. in diameter, appeared suddenly from beneath the lower eyelid. In due course, the girl confessed that she had prepared these "stones" by moistening small pellets of cotton wool with her saliva; they were then blackened with charcoal and rolled into shape between the fingers.

The common situation for rhinoliths is the lower half of the nose, about midway between the anterior and posterior nares, and probably all of those which, when discovered, filled the nose, had begun in this region. Amongst 44 of the smaller stones, 37 were found in the lower half, and only 7 in the upper half, of the nose. The site usually mentioned was either on the floor of the nose, or in the inferior meatus, or between the inferior turbinate bone and the septum, at about the middle third, in the antero-posterior line, of the fossa. Bross found that 80 per cent. occupied the inferior meatus; Hérisset found this site, or the floor most often occupied. The stones described, for example, by Bovill, Hendley, Hutcheon, Poole and Zuckerkandl, were of considerable size and filled the nasal fossa; a few rhinoliths had extended into the opposite fossa or the adjacent antrum. Intermediate phases of rhinolith development are represented by the specimens of Fotiade and Hall, present in the inferior and the middle meatuses. Schmiegelow described inclusion of the inferior turbinate bone in a fork of calcareous material, an extension of a rhinolith in the inferior meatus.

The anterior limit of a rhinolith may be at, or even external to, the anterior naris. Some eight stones were within an inch of it, and, indeed, the stone in Bovill's patient, who himself diagnosed the condition, projected slightly from the nostril. Clutton's patient had felt the rhinolith with her finger.

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Recognition of the stone by posterior rhinoscopy was also occasionally reported as by Gorman, Lang, Moure, and by Polisar; in four patients, those of Faith, Francis, Kelemen and Polisar, the nasal stone extended through the choana into the nasopharynx.

Lateral enlargement of rhinoliths occurred more often on the septal than on the antral side, probably because the septum yields more readily. Severe septal deflection to the opposite side of the nose, in consequence of pressure by a large rhinolith was described by some 22 authors. There were at least seven more cases, those of Botey, Clauder, Cozzolino, Hessler, Presencia and Ucelay, Smith (L. W.), and Zuckerkandl, where the rhinolith had extended through the septum into the opposite nasal fossa. Extension into the antrum, according to the present search, was described by five authors, namely Hall, Hutcheon, Kelemen, Lobell, and Snyder and Feldman.

The measurements of 75 rhinoliths ranged from 9×6 mm., or $\frac{3}{8}'' \times \frac{1}{4}''$, (Lee Felt) to 55 mm. \times 18 mm. (Poole). Small, medium and large stones were represented by those of from 9-20 mm., 21-30 mm., and 31-55 mm., in length. These three groups included 19, 39 and 17, respectively. Seifert cited Brown's as the largest rhinolith, no doubt because he believed it to be 5 cm. long. This stone, however, measured only $1\frac{3}{8}'' \times 1'' \times \frac{1}{2}''$ ($34 \times 25 \times 12.5$ mm.) and, although in the group of large stones, it was appreciably smaller than at least five other rhinoliths, for example, those described by Cosson, Hendley, Poole, Ruault and Zuckerkandl, each of which were at least 50 mm. long.

The weights of 84 rhinoliths ranged from 0.3 gm. (Heinemann), and 0.4 g., or $6\frac{1}{2}$ grains (Baber, 1885) to 110 grammes (Botey), and the latter seems likely to remain for all time the heaviest rhinolith on record. Error has occasionally arisen in respect of the rhinoliths described by Clay and by Hall, "grains", having been translated by some authors as "grammes". These two stones weighed, respectively, 110 grains or 7.1 gm., and 92 grains or 6.0 gm., which at once withdraws them from the group of large rhinoliths. The majority, 51 of 84 rhinoliths, weighed 5 gm. or less. The present series of 84 included 13 of under 1 gm., 38 of 1-5 gm. and 16 of 5-10 gm., whereas there were only 17 of over 10.0 gm., but of these 8 were of from 45-110 gm.

Barraud appears to be the only author to record the specific gravity of a rhinolith, which was 2.21.

No author, as yet, has described a rhinolith which was wholly smooth, but several rhinoliths were grossly irregular. Bishop and Trimarchi, for example, likened their specimens to coral and Clay's wood-cut depicts a remarkably irregular stone. Hérisset compared the surface to that of pumice stone. Mammillation was occasionally noted, and the large stones usually formed an imperfect cast of the nose, as described by Agar, Doss, Hendley, Presencia and Ucelay, Taylor and others. Smaller stones were

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usually more irregular on the antral than on the septal aspect. There are two instances of annular rhinoliths. Nasal obstruction in Rendu's patient, a boy aged 12 years, was ultimately demonstrated to be caused by a rectangular stone, of about $15 \times 15 \times 3$ mm, containing a central space about 8 mm in diameter. Rendu believed that a small metal ring or a button had occupied the centre of the stone, and had been expelled spontaneously. The stone removed from Fearnley's patient, of whom few details are given, appears to have been similar.

The external surface of a rhinolith is usually a shade of brown, ranging from off-white to dark brown, in different specimens. Others were described as black or of greyish colour, and a few were tinged with green. The brown, and possibly black, tints, are caused by altered blood pigment, derived from capillary hæmorrhages, due to capillary erosion by the rough surface of the stones, many of which were slightly mobile. Suppuration and putrefaction are probably responsible for green or black discoloration. The internal appearances are not unlike those of vesical calculi, as first noted by Moriarty. The phosphatic material is of almost white colour, and somewhat granular. Again, as in vesical calculi, lamination was sometimes seen, as in the specimens of Bleicher, Bovill, Hutcheon, Ireland, Miot, Stoker, Symonds and others. Laminae in vesical calculi usually differ in composition, phosphatic layers being separated by, say, layers of uric acid. It has not yet been demonstrated what difference, if any, exists between the several layers of a laminated rhinolith. The consistence of many stones was distinctly hard, but there were others which were friable, and of chalk like consistence.

Since all calculi, it seems, form around a nucleus, be it only a crystal, the distinction between rhinoliths as "false" and "true", based on the presence or absence of a visible nucleus, has only the sanction of long usage to warrant its retention. It is suggested that rhinoliths be distinguished as either of exogenous or endogenous origin, to indicate the source of the nucleus.

Garel, Guttmann, Herisset, Joukovsky, Key-Åberg and Seifert all supported the view that most rhinoliths contain an exogenous foreign body, a view which is now confirmed by published records. Middlemass Hunt found that 85% contained a nucleus, of which 80% were exogenous foreign bodies. Snyder and Feldman are almost alone in their view that "This form is not as common as the true type". The present enquiry yielded evidence of 209 rhinoliths which contained exogenous nuclei. Even were it assumed, which is unjustifiable, since no examination was made in many cases, that the rest of the 384 rhinoliths contained endogenous nuclei, the former group is still the larger. Analysis of the 257 verified reports showed that 139 of these rhinoliths contained exogenous nuclei, whereas there were only 19 of endogenous origin. Incrusted teeth were present in 7, sequestra in 4, and blood clot was,

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perhaps, the nucleus of another 8, although this latter group is open to question. Only 31 of the remaining 99 rhinoliths appear to have been examined to discover a nucleus, and in 9 of these the negative examination was admitted to be inconclusive. In short, present evidence shows that the ratio of exogenous to endogenous nuclei is 139 : 19, or about 7 : 1.

Nuclei of Exogenous Origin

Although many materials, either mineral, vegetable or animal, have been found in rhinoliths, only a few were present with any regularity. It has long been recognized that cherry stones are frequently the nuclei of rhinoliths. No less than 75 are now traced ; the first was described by Bartholin in 1654. This high incidence of cherry stones amongst exogenous nuclei, 75 out of 209, or about 36 per cent., is more than fortuitous. Fruit stones, other than of cherries, together with peas, beans, nuts, berries, sunflower seeds and the more unusual nuclei, like caroub seed (*Nemai*) totalled only 34, or 16 per cent., of which one-half were hard fruit stones or nuts. The shape, size and weight of a cherry stone combine to favour a lengthy stay in the nose. The initial symptoms are likely to pass speedily and then a latent period, probably lasting years, as in Handford's and other cases, is to be expected. Moreover, until incrustation has advanced appreciably, the stone may be difficult to detect, even if symptoms occur. Other fruit stones, by virtue either of their larger size, or sharp surfaces, for example prune, apricot, date or olive stones, rarely occurred in rhinoliths ; large fruit stones of this kind are likely to be promptly removed. Peas and beans, which tend to swell considerably, soon cause severe obstruction, leading to prompt removal. It is somewhat surprising that orange or lemon pips are rare nuclei ; only one instance was found (*Moure*). In Russia sunflower seeds rank high as potential nuclei of rhinoliths (*Joukovsky*, *Alskne*).

Buttons, next in frequency, totalled 18, or only 8.6 per cent. of exogenous nuclei. Pieces of paper, some of which, as described by *Seeligmann*, 'still bore lettering legible under low magnification, were found in another 13, and pebbles or small stones were found in 8 rhinoliths. The low incidence of cotton wool, present in only 9 rhinoliths, is another surprising fact, when the wide use of cotton wool swabs in the nasal toilet of infants is recalled. *Holmgren's* patient aspirated a wool tampon from its mother's breast. Other exogenous nuclei included half a dozen beads (for example, *Glas*, 1919, *Taylor*, *Law*), two seashells (*Major*, *Tanner*), pieces of wood (*Köhler*, *Joukovsky*), slate pencil (*Bark*), black silk (*Noquet*), rag (*Baber*), cork (*Chiari*), rubber (*Key-Åberg*, *Khan* or *Kan*, and *Krebs*), a small screw (*Jurasz*), and a piece of twine (*Snyder* and *Feldman*). Two snuff takers acquired rhinoliths (*Böhm*, *Ruault*) ; *Böhm's* patient was addicted to "Schmaltztabak", a Bavarian snuff

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freely adulterated with ground glass and chalk, of which the rhinolith, nucleus was composed

Nuclei of Endogenous Origin

Teeth, misplaced into the nose either through developmental errors or trauma, occasionally become incrustated, but usually differ from rhinoliths, with the exception of A J Wright's antral rhinolith, in that they retain a point of attachment to some part, usually the floor, of the nasal framework Presumably a tooth wholly displaced into the nose is promptly removed, and never forms a rhinolith, it may rarely do so in an antrum Graham described an extraordinary case in which a tooth, wholly displaced into the nose, was found embedded in the inferior turbinate bone "where it had taken root and was growing vigorously", it had been driven right through the superior maxilla The first example of an incrustated tooth was described by Wepfer (1727), the sole remaining upper tooth, an incisor, of a woman aged 70, projected into the nose and became incrustated Other cases were reported by Arauz and Belou, A J Wright, Jonathan Wright (two cases), Kayser, Baumgarten, Popoff, Glas (1907, republished 1913), and Seifert Several nasal teeth have been described but only a proportion appear to have been incrustated The nasal tooth, which was associated with, and probably the cause of "rhinitis caseosa" of 13 years' duration in Abercrombie's patient, apparently was not incrustated

Although not a few rhinoliths were at first thought to be sequestra, the latter are rare amongst endogenous nuclei The rhinolith in Cheatle's patient contained a fragment of bone, because the inferior turbinate was absent when the nose was examined after the extraction of the rhinolith, he thought the missing bone had become a sequestrum, and later the nucleus of the rhinolith There was clinical evidence of syphilis Mascarel's patient differed only in that trauma, a blow on the nose by a bull's horn, was deemed the cause of necrosis of the inferior turbinate bone The cases of Middlemass Hunt and Fethke were also of rhinoliths around sequestra A piece of dead bone was found by Silitch in one of his rhinoliths, but no details are available Bone, probably of exogenous origin, was also present in rhinoliths described by Chiari, and by Nourse

Dried blood clot may occasionally cause mechanical obstruction and become the nucleus of a rhinolith The best known and most convincing example is Moure's case, which is supported by adequate histological (Sabrazès) and chemical (Denigès) evidence Others have described soft bright or dark red material apparently clot, as a nucleus Sanders found that the nucleus of Brown's specimen contained fatty matter and iron, but Irvine, who confirmed the presence of iron oxide in the ash, believed it exogenous Utz found fibrin mingled with blood clot in Francis' specimen but, since he received only part of the stone, the presence of an

exogenous foreign body was not wholly excluded. Spectroscopic demonstration of blood in Scheppegegrell's specimen scarcely confirmed that the nucleus was blood clot; traces of hæmoglobin or other blood pigment in the incrustation would be difficult to exclude; spectroscopy was negative, however, in Clutton's specimen. Bright coloured material, believed to be blood clot, was found in the centre of Stoker's rhinolith. Other authors who suggested that the nucleus of their specimens was clot include Binder, Monnié and Wagner.

Although within the bounds of possibility, as first suggested by Plater (1736), dried nasal secretion has yet to be proved the nucleus of a rhinolith. Of the six examples cited by Seifert, Verneuil described "*une sorte de graine, qui, par sa forme, rapelle la forme d'un pépin de raisin*", in the fragments of his specimen. The abstracts by Didsbury and Hérisset of Berlioz's case go no further than to state that no nucleus was found. The original reports by Guttceit and Löwenthal are not available, but Chiari classed the former as a rhinolith without a nucleus. Hicquet's report has not been traced, Seifert's reference being incorrect. Voltolini's case is a debatable example. If crusts become nuclei, their rare occurrence in rhinoliths is surprising, since crusts are common in the nose.

The formation of rhinoliths around clumps of desquamated epithelium, bacteria or even a group of crystals precipitated from the nasal secretion, tears, or products of inflammation, is a possibility, but no instance has yet been proved. Admittedly proof is difficult, and this conclusion is permissible only when thorough investigation has been made. Morell Mackenzie said that "*occasionally in the centre of the calculus an albuminous liquid or a fatty proteine substance has been found, but it appears doubtful whether in these cases the matter contained in the centre of the calculus was the remains of the original morbid secretion, or whether it was due to the softening of some foreign material primarily forming the nucleus of the stone.*" Of his second specimen, he said that no nucleus was found "*but if there had been one it might easily have eluded observation*", the stone having had to be crushed into small fragments to admit its extraction. By inference, but not by explicit statement, he suggested that all rhinoliths probably contained exogenous nucleus.

The Chemical Composition of Incrustations

Many authors give the results of qualitative analysis and at least twenty quantitative analyses have been reported. Geiger's analysis of Axmann's specimen in 1829, the first analysis on record, demonstrated 0.35 of animal material, 0.8 of calcium phosphate, 0.325 of calcium carbonate, 0.125 of magnesium carbonate with traces of soda, of muriate of soda and iron oxide. Subsequent analyses have confirmed that these constituents and the high phosphatic content are almost constant findings. The results are expressed by some authors in terms of

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phosphorus pentoxide and calcium oxide, whereas others state the amounts of calcium and magnesium phosphate and carbonate present. The fifteen analyses reported by Alskne, Bergstrand, Berlioz (four specimens), Herisset (two specimens), Key-Åberg (two specimens), M'Wheeny, Melzi (two specimens), Moure-Denigès, and Polo are the basis of the following observations

Incrustations, according to these analyses contained, on the average, 4.7% of water, 16.54% of organic matter, 59.20% of calcium phosphate (an average of 12 results), 5.73% of magnesium phosphate (an average of 10 results), and 11.60% of calcium carbonate (an average of 10 results). Other substances were present only in traces as a rule, appreciable amounts of iron or oxalic acid, for example, were exceptional.

Amongst these analyses, the constituents were within the following limits: water, from 2.9% (Melzi) to 6.9% (Berlioz), organic matter, 13.2% (Melzi) to 31.9% (Key-Åberg), calcium phosphate, 44.7% (Key-Åberg) to 79.5% (Melzi), magnesium phosphate traces (Key-Åberg) to 19.46% (Herisset), and calcium carbonate, traces (Moure) to 20.69% (Berlioz). Seifert found that the organic content ranged from 5% to 35%, Key Åberg said it averaged 23%, and Trimarchi gives the range as from 15% to 20%. In the four analyses of Berlioz, organic matter was from 16.0% to 18.2%. Trimarchi found calcium phosphate ranged from 47% to 63%, calcium carbonate from 3% to 10% and magnesium phosphate from 9% to 20%.

The composition of the nucleus at times caused appreciable modification of that of the incrustation, notably when metal boot buttons were nuclei. These foreign bodies contributed iron salts to the incrustation, which contained 37.3% of iron in one of Seeligmann's specimens, 36% in Moeller's, over 30% in one of Baber's, and 15.1% in one of Key-Åberg's specimens. Oxalic acid amounting to 0.6% of an incrustation was demonstrated by Guttman, who subsequently found traces of oxalic acid in two other rhinoliths, which also contained cherry stones, by contrast oxalic acid was absent from the incrustation of two rhinoliths which did not contain cherry stones. The source of the oxalic acid, therefore, appears to be the cherry stones, and some were dried and submitted to analysis, this sample contained 0.55% of oxalic acid (Polson).

The composition of antral stones, as judged by Oppikofer's analysis, already cited, probably differs in no material fashion from that of nasal stones.

The Route of Entry of Foreign Bodies

Exogenous foreign bodies usually enter the nose by the anterior nares, being inserted either by the patient or some other person. Occasionally the foreign body enters by the posterior nares and it is probable, as believed by Hopmann, that many, derived from food, enter

by this route. This is predisposed to by vomiting, or retching, or unexpected sneezing, or laughter when the mouth contains food. Key-Åberg maintained that few foreign bodies entered by the posterior route and then more often in children than in adults. The clinical histories, as might be expected, rarely give precise details of the accident, because the long interval, which usually elapsed between the entry and removal of the foreign body, had obliterated memory of the earlier event. Moreover, the initial symptoms were usually transient.

The cherry stones removed by Fotiade, Handford, Ripault and Tillaux, were all inserted by the patients, but entry by the posterior route occurred in Minkewicz's patient during an attack of vomiting. The miller described by Horn (1788) aspirated a cherry stone while eating cherries. Deschamps described a case of obstruction of the left nasal fossa by a piece of bone. Twenty-five years previously, while the patient was taking soup, a piece of bone stuck in his glottis. After a paroxysm of coughing and partial asphyxia, it was ejected, passing upwards to gain the nose *viâ* the posterior nares.

Foreign bodies occasionally gain the sinuses and, less frequently, the nose, as a result of trauma. Several of these reports concern the misplacement of apparatus used to drain an antrum, through the socket of a tooth. Illustrative cases include those described by Abad and Magboo, Ballenger, Barola, Moore, Reynolds, Voorhees and Weill. These foreign bodies, however, do not appear to have been incrustated, and no instance of the kind has been found. In the light of these records, the scarcity of antral rhinoliths and their absence in all other sinuses, would suggest that certain factors necessary for incrustation are lacking in the sinuses.

Patients with developmental defects, such as a cleft palate, may acquire nasal foreign bodies by these abnormal paths, but no instance, however, appears to have been recorded. There is one report of a foreign body which entered the nose through a palatal defect of pathological origin. The velum and arch of Khan's patient were destroyed by syphilis, and a prosthetic appliance was fitted to occlude the defect, through which, however, it entered the nose.

The lachrymal duct is another possible route of entry of foreign bodies, although likely to be concerned only in exceptional circumstances. Ónodi, it appears, described a lachrymal stone in the nasal cavity, and the cases of Mounier and Faure are cited by Key-Åberg. That of Mounier, however, is a lachrymal stone, formed around a small glass cannula used, some forty years previously, to clear the duct. The stone was found in the duct and removed *viâ* the nose; it was not a rhinolith.

Ætiology and Pathogenesis

The principal factor which predisposes to rhinoliths is the entry and lodgement of a foreign body in the nose. This, however, as several

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reports show, is not of itself a sufficient cause. Antral foreign bodies are not rare, yet their incrustation is distinctly uncommon and by no means all foreign bodies which lodge in the nose, and which remain there many years, become rhinoliths. It is necessary that the lodgement of a foreign body instigates suppuration. Mechanical obstruction to the escape of pus, by the foreign body and other sources of obstruction, expose it unduly to air currents in the nose and, in consequence, the pus is concentrated beyond the point at which salts, notably those of calcium, will remain in solution. They are then precipitated on the surface of the foreign body and in time it becomes incrustated. Inspissation of pus by a similar process is also responsible for the complication of "rhinitis caseosa" (Polson, 1942). The rarity of antral rhinoliths is probably to be explained by the absence of air currents in that backwater of the nose, or, at any rate, the absence of currents comparable to those in the nasal fossae. In both there is the factor of obstruction to free escape of pus, and, indeed, this is probably greater in the antrum than in a nasal fossa which contains a foreign body.

The origin of the calcium salts has been debated. Some have favoured the tears and others, nasal mucus. Tears apparently contain traces of calcium (Demarquay). Although tears may, in small part, be a source of incrusting salts, there is little doubt that the principal source is pus. Samples of pus were analysed, and yielded the following results: (a) peritoneal exudate from a case of general peritonitis, complicating an appendix abscess: calcium content: 0.31%, dry weight; (b) pericardial exudate from a case of suppurative pericarditis: calcium content: 0.13% dry weight \equiv 11 mg. Ca. per 100 c.c.; phosphate content: 32.3mg. inorganic P. per 100 c.c. \equiv 102 mg. phosphoric acid per 100 c.c.; (c) peritoneal exudate from another case of general peritonitis, complicating appendix abscess: calcium content: 0.15% dry weight \equiv 17 mg. Ca. per 100 c.c.; phosphate content: 36 mg. inorganic P. per 100 c.c. \equiv 116 mg. phosphoric acid per 100 c.c. Nasal pus was not available. The phosphate values were artificially raised by post-mortem change, but like changes probably occur in pus retained in the nose.

The pathogenesis of rhinoliths of endogenous type is similar when the nucleus is a misplaced tooth, sequestrum or perhaps dried blood clot. Those without demonstrable nuclei are less easy to explain. It is a reasonable supposition, however, that the mechanism is not unlike the formation of crystals from a super-saturated solution. The suspension of even a single crystal of the solute in this solution is sufficient to initiate crystallization. A foreign body is not the only source of mechanical obstruction in the nose, and, as has been discussed elsewhere (Polson, 1942), the nasal anatomy of itself, swollen mucosa, granulation tissue or mucous polypi have at one time or another operated to cause inspissation of pus in the nose. In due course precipitation of calcium and magnesium

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salts may enclose desquamated epithelium, a clump of bacteria or, possibly, a crust, which becomes the nucleus. Precipitation of salts is also probably favoured or accelerated by changes in the hydrogen-ion concentration of the nasal secretion, as has been shown in respect of biliary calculi.

Trauma played a part in the origin of some rhinoliths. Prior operative treatment was responsible for the genesis of a rhinolith in four cases; a gauze swab was overlooked during an antral operation, and found three years later in a rhinolith (Snyder and Feldman),* the misplacement of a laminaria provided the nucleus of another, dental extraction was responsible for rhinoliths in the patients described by Johnathan Wright and A. J. Wright; in the former a fragment of tooth, $\frac{3}{4}$ in. long, penetrated the nasal floor and became incrustated, and in the latter the root of a first molar was displaced into the adjacent antrum, ultimately to become the nucleus of a rhinolith. Blows on the face or nose also appear to have been the initial factor in six cases; Agar's patient sustained a kick from a horse, those of Allen and Mascarel were struck on the nose, and those of Clay, Hérisset and Felici fell on their face. In another patient a wheat grain was forcibly driven into the nose and ultimately became a rhinolith (Krebs).

Industrial conditions are also a factor in the causation of some rhinoliths. Betz, in a brief statement, without illustrative cases, said that 10 per cent. of workers acquired rhinoliths from cement dust, which also predisposes to septal perforation. L. W. Smith is the only author now found to have described a case. Joukovsky mentioned that rhinoliths may occur amongst workers in cloth and in salt mines, but no illustrative case reports have been traced.

The Symptoms and Signs of Rhinoliths

A detailed account is not attempted, but there are certain changes which may be discussed, either because of their frequency, or because of their interest.

It is clear that almost all rhinoliths will, sooner or later, make their presence known. Only four in the present series were found by chance in the course of a routine clinical examination. One patient was an apparently healthy naval rating (Camerer), another complained of laryngitis (Guttmann) and the third of otitis media, in no way a complication of the rhinolith (Bishop). A fourth is described by Hirschmann as a chance finding, but the patient had had slight obstruction of the right nose. Although Fearnley described his specimen as "discovered by accident", the patient had had an offensive unilateral nasal discharge for months. Pavey-Smith's specimen was found during operation for sub-mucous resection of a deflected septum.

* See also Pavey-Smith's case, in the Addendum.

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Symptoms at the time of entry of the foreign body were usually of minor character and were often long forgotten by the patient. A latent period, even of several years, may follow, as is well illustrated by the patients of Handford and Sewell. This interval may be symptomless, but, sooner or later, some of the changes described below will appear, and their relief follows only when the cause is determined, and the rhinolith removed.

Although a number of symptoms have been ascribed to the rhinoliths, few occurred with outstanding regularity. Unilateral nasal discharge was particularly common. Almost all patients, as judged by about 180 reports which mention clinical details, had had a nasal discharge, which was usually purulent, often foetid and sometimes blood-stained, as noted in at least 114 of the histories. Simple catarrh, on the other hand, was exceptional, and mentioned in respect of only seven patients, in one of whom it was of sudden onset. Absence of discharge was specifically mentioned only by McBride and by Nourse.

Unilateral nasal obstruction, either as a complaint or as determined by examination of the patient, was almost as common as nasal discharge. Obstruction was recorded in at least 92 reports, and occasionally, owing to displacement of the septum, it was bilateral. The onset of obstruction was a gradual process, often taking several years to become complete, an indication of the time required for the evolution of rhinoliths, even of moderate size. In several patients obstruction preceded the discharge by many years, for example, obstruction existed in one of Garel's patients for forty years, whereas the discharge was present for only one year.

Nasal discharge and obstruction are the two cardinal symptoms, and co-existed in at least 56 patients.

Epistaxis, at least mild, might also be expected to be common, since many rhinoliths are rough and somewhat mobile, and are likely to damage the nasal capillaries. Epistaxis was reported, however, in only 17 patients, in two of whom (Francis, Jana) it was deemed the cause and not a result of the rhinolith. Even when bloodstained discharge be included as "epistaxis" the total is raised by only another seven cases.

Certain other symptoms or signs comprise a "syndrome", which characterizes rhinoliths which have been long neglected, and have attained appreciable size. These include swelling of the nose or face (24 cases), epiphora (14 cases), and conjunctivitis (3 cases), the ocular troubles arise from obstruction of the lachrymal duct.

Headache is sometimes mentioned as a cardinal and some speak of it as a constant symptom (Noquet), but in this series it was a complaint of only 23 patients. Headache may be intense, and is not infrequently localized in the frontal region. There were 8 instances of neuralgia, 5 of migraine, and 2 of attacks of giddiness (Tormene, de Santi).

Mouth breathing (5 cases), and a nasal voice (3 cases), were uncommon.

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symptoms. Anosmia occurred in only two patients; three others complained of vomiting, and only one had dysphagia. Other occasional symptoms included: the sensation of a foreign body in the nose, nasal discomfort, attacks of sneezing, and excoriation of the lip. Unilateral sweating of the face, in Schmiegelow's patient, appears to have ceased some time before the rhinolith was removed; he explained this on the ground that the stone, being enlarged, had later paralysed the nerves responsible. Joukovsky also noted this sign in one of his patients.

Granulation tissue, or inflamed mucous membrane,* or mucous polypi, may lie anterior to the stone and obscure it; at other times a deflected septum may preclude satisfactory anterior rhinoscopy.

There may be ulceration of the nasal mucosa, and destruction of the septal or antral walls. Perforation of the palate, of syphilitic origin and not due to the rhinolith, was mentioned by Khan (or Kan). Displacement of the palate by a rhinolith, as in Bovill's patient, is rare. Atrophy of the inferior turbinate bone occurred in seven patients, and in another two, this bone was absent and apparently became the nucleus of a rhinolith. Deflection of the septum to the side opposite to the rhinolith occurred in 22 patients. Signs which are peculiar to the stone may be inferred from the description of the morbid appearances (v.s.). It suffices, here, only to stress that the discovery of a hard body in the nose by probe examination is of prime importance.

Duration of Symptoms, and Stay of Foreign Body

The times sometimes quoted to express the duration of symptoms are actually those during which a foreign body had been in the nose or antrum, and the two periods are rarely identical; a foreign body frequently remains in the nose for a considerable time before symptoms, other than those, which attend its entry and soon pass, are apparent. The foreign body present in Sewell's patient for 44 years eventually caused symptoms of only four months' duration; Thost's patient was similar. The division of symptoms into the three phases, initial, latent or incubation, and inflammatory has its merits (Trimarchi, Tormene).

Foreign bodies may stay in the nose for remarkably long periods, even for sixty years (Thost, Weismann). One of Guttman's patients, aged 62, probably acquired the foreign body when he was aged 12. The presence of a foreign body for 50, 46, 44, 40 (2 cases), and 30 years (3 cases), was probable in the respective patients of Guthrie, Hirschmann, Sewell, Cosson, Krause, Hopmann, Bleicher and Tanner; another instance of long retention of a foreign body, for 27 years, was also described (Handford), and in another four patients the stay was assessed at 20-25 years (Fotiade, Hajek, Power and Verneuil).

* See Stirk Adams's case, in the Addendum.

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Symptoms, although usually of shorter duration than forty years, have none the less lasted for remarkably long periods. Baelde's patient had had symptoms for 33 years, and Ingersoll described a patient, who had had symptoms for 30 years, J F Hill's patient suffered for 25 years. Although these are extreme examples, 116 clinical histories, which relate the duration of symptoms, are mostly in agreement in showing that the time is to be measured in years rather than months. Symptoms which lasted less than one year were recorded of only eleven patients, whereas there were 69 patients whose symptoms had lasted from one to ten years, and in another 17 for from 11 to 40 years, 19 patients had had symptoms for an unspecified number of years.

The length of time which patients have tolerated their symptoms is noteworthy, especially when the unpleasantness of nasal discharge and obstruction is borne in mind. A few have been unfortunate in their doctors, but it seems that the real cause of this tolerance is a low grade mentality. When stated, the occupation of the patient is usually of the labouring kind, whereas only two professional men, Baber's medical practitioner and a clergyman (Allen, case 2), appear to have had rhinoliths, Baber's patient had symptoms for only three months. Although rhinoliths have occurred in his hospital clinic, Mr E W Bain has never had a case in private practice.

Diagnosis

Tanner (1862) stressed the importance of a search for intranasal foreign bodies in all cases of ozaena and many reports indicate the value of probe examination in this search, and its importance in the exclusion of malignancy (e.g. Hewetson's case). In skilled hands, this simple instrument appears to be a sure means of detecting rhinoliths and other intranasal foreign bodies, even though it may not determine their precise nature. The records of patients, in whom accurate diagnosis was for long delayed, usually indicate that delay was in the main due to the omission of probe examination of the nose. Spicer said that 'Foreign bodies in the nose in children, from the smallness of the channels and from the swelling—usually secondary to previous attempts at removal or to consecutive rhinitis—are not usually to be detected, even by skilled rhinoscopy, and the diagnosis must depend on the probe'. Didsbury and, later, Guttmann, also emphasized the value of probe examination.

Radiological examination of the nose was apparently attempted for the first time in this country by Macintyre, who, in 1900, described the use of Röntgen rays in the detection of an antral foreign body. Scheier published a radiogram of a metal body in the nasal cavity in 1897.

Ruault, in 1904, having diagnosed a rhinolith on clinical evidence,

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proceeded to determine whether it was opaque to X-rays. Hérisset says, of Ruault's first case, that a central zone, of oval form, occupying the site of the cherry stone subsequently removed, was noted in the radiogram; the second rhinolith was also opaque, and there appeared to be a fissure in it, apparently between the incrustation and the nucleus. Radiology does not appear to have been applied to the diagnosis of rhinoliths during the ensuing twenty years. The next mention of it is in a brief note by Glas (1925); the case reported by Kelemen, 1926-27, is illustrated by two excellent radiograms; Lobell's (1927) two patients were submitted to X-rays, and the findings were interpreted as evidence of bone necrosis in the nasal floor; the radiogram of Locy's (1929) patient showed a particularly dense shadow, of circular outline, involving the nasal floor, and inferior turbinate bone; the appearances were thought those of an osteoma. Radiograms were also made of one of Joukovsky's (1931) patients, of Polisar's (1933) two patients, of those of Snyder and Feldman (1936), of Runge (1931-32) and of Hutcheon (1941). When radiograms have the quality of Kelemen's illustrations they cannot fail to assist diagnosis, but the requisite staff and apparatus are not always at hand and, in consequence, the probe is likely to retain its supremacy. Radiology may, perhaps, excel in the assessment of any damage to the nasal framework, but most reports indicate that even large rhinoliths may have but slight destructive effects upon the nasal interior.

Prognosis

Once the stone is detected, and successfully extracted, prompt relief from symptoms, and a speedy return to normal, despite years of prior suffering, may be anticipated. It is somewhat surprising that even large rhinoliths, with the attendant difficulties of removal, were usually unaccompanied by gross structural damage. In only a few cases was there atrophy or loss of the inferior turbinate, or erosion of septal or antral walls. The fatal termination in Key-Åberg's case is apparently unique.

Complications

Rhinoliths were almost without complications, despite the long periods for which many of them had remained in the nose. Except for "rhinitis caseosa" and secondary sinus inflammation, other complications were unusual, if not rare.

"Rhinitis caseosa" is but a variant of suppurative rhinitis, in which obstruction to the escape of pus causes its inspissation, with the production of distinctive clinical phenomena. Although rhinoliths, together with foreign bodies, granulation tissue and like mechanical obstructions are important factors in its causation, "rhinitis caseosa" was present as

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a complication of only thirteen rhinoliths. Of these cases, the reports by Calamida (three cases), Handford, Hill, G W, Moure, de Rosa and Verneuil are generally known, but this opportunity is taken to add five cases which escaped attention in my former review (Polson, 1942)*. A "rhinolith combined with cholesteatoma of the maxillary antrum", the findings being essentially those of an established "rhinitis caseosa", due to a rhinolith, was described by Hutcheon, 1941. The cholesteatoma theory, however, is a long time a dying. Mascarel's (1852) report is also of another good example which has been generally overlooked. He described the powerful foetor as an "odour sui generis", apparent when entering the patient's room. A rhinolith was detected and its removal was followed by the spontaneous expulsion of "une grande quantité de la matière ichoreuse", it will be recalled that this report appeared some twenty-two years before Duplay introduced the term "coryza caseux". Moriarty's case (1886) is another good example which has also been overlooked. He described the expulsion, subsequent to the removal of a rhinolith, of "a quantity of greyish-white, putty-like material, not unlike brain matter, finishing with a huge plug which evidently had occupied the posterior nares". The cases of Ruault-Herisset and Key-Åberg are less certain examples of "rhinitis caseosa" but the former wrote of a rhinolith "inclus dans de masses caseeuses" and the latter of a little caseous material and pus lying behind the rhinolith.

Sinusitis or sinus empyema were mentioned in less than twenty reports, and the view of Seifert, who mentioned only Morell's case, that this is a rare, or unusual, complication is confirmed. Gorman, on the other hand, believed it a usual finding, but Key-Åberg, in addition to his 3rd and 4th cases collected only five others reported after 1900, namely, by Gerber, Krebs, von Gámán, "Barranel" and Lange (1913), and of these, he questioned that of Barranel (i.e. Barraud), because the diagnosis rested only on transillumination. During the ensuing twenty years, sinusitis was mentioned in only nine new reports, namely, those of Bleicher (case 2), Gorman, Guttmann (case 5), Hutcheon, Kelemen, Lobell, Snyder and Feldman (cases 2 and 3), and A J Wright. Involvement of the sinuses is usually restricted to the antrum adjacent to the rhinolith. There are, however, five instances of multiple, unilateral sinusitis described respectively by Gorman, Key-Åberg, Snyder and Feldman (2 cases), and A J Wright. In view of this evidence, and with due allowance for any omissions, it is not correct to say that "the involvement of the sinuses on the affected side was commonly observed in most of the reported cases".

Ear trouble, notably middle-ear disease, is a rare complication of rhinoliths. According to Key-Åberg, otorrhœa and deafness were mentioned by Cozzolino and otitis by Sokolowski and Tormene, sclerosis

* See also Stirk Adams's case (1943) in the Addendum

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of the middle ear and labyrinthine disease occurred in one of Rohrer's patients. The present search discloses only one other instance of otitis media due to a rhinolith, seen in Janatka's patient, already mentioned. Although Milligan's patient (1896) had otitis, this was not ascribed to the rhinolith.

One instance of septal abscess was recorded (Minkiewicz). These, apparently, are nearly all due to trauma, and a rough, hard, and sharp foreign body, like a rhinolith, might be expected to cause this complication more frequently. Runge found an abscess of the inferior turbinate bone in his patient. There are a few instances of long neglected rhinoliths, associated with fistulae between the nose and face, but there is only one of an orbital abscess (Key-Åberg, case 3). This patient suffered almost all the possible complications of a rhinolith and eventually died of meningitis, secondary to the abscess in his orbit. This still remains the only fatal case in the literature.

Tormenê described a patient who had, amongst other troubles, epileptiform convulsions, cured by the removal of her rhinolith. Rohrer's patient had a "reflex neurosis" cured in like manner. No instance of asthma as a complication was traced, but Guttman said that reflex asthma had been cured by removal of a rhinolith.

Treatment

The majority of the stones were extracted anteriorly by traction with suitable instruments. Larger stones required piecemeal removal, or they had to be crushed, in order to remove them. Most were removed *viâ* the anterior nares, but some had to be displaced backwards into the nasopharynx, whence they were removed by the surgeon, or expectorated by the patient. It is a manœuvre which obviously requires precautions against the displacement of the rhinolith into the larynx or trachea, if the patient be under general anæsthesia. Radical operations were occasionally undertaken to deal with the large stones, for example by Myerson, Hendley and Kelemen. Hæmorrhage is the principal operative complication and, although Gorman found it "terrific", and Doss "profound" only six others comment on its severity, whereas there are several other records, which state that only slight hæmorrhage occurred. It seems that in all cases, suitable measures soon brought the hæmorrhage under control.

Spontaneous expulsion, in response to an irritant inhalation, for example, snuff, may take place (Axmann's case), and might be attempted as a preliminary step, if there is reason to believe the stone is small. Brodie's patient, for example, expelled the stone on blowing her nose, as did A. J. Wright's patient, six weeks after two radical operations for sinusitis.

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- COSTEN, J B, *J Missouri M A*, 1939, xxxvi 266 8, rhinolith associated with diphtheroid bacilli bead nucleus
- COUPARD, G, *Bull Soc de méd prat, Paris*, 1888, 242 5, *Index-Cat Surg Gen* "Nasal foreign bodies causing symptoms of ozaena" ? case report
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- CURTIS, H H, ? 1901, cited by Lee Felt rhinolith in gouty subject, no nucleus found
- CZARDA, G, *Gaz méd de Paris*, 1884, Nos 49 et 50, 7^e série, tome 1, 580 81, *ibid.*, 591-3 three rhinoliths and two nasal foreign bodies reported, brief review; case 1, wool, case 2, prune stone, case 3, jumper berry

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- KLEIN, W, ? 1906, cited by Key-Åberg ? case report
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- KOHAN, L N, *Prakt Vrach, St Peters* 1908 vii, 528-30 per *Index Cat Surg Gen* "nasal calculi"
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- KÖNIG, ? 1878, cited in an annotation, *B M J*, 1885, ii, 662 4 ? case report

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- M'WHEENY, FALKNER, *Dublin J. Med Sci*, 1889 lxxxvii, 165, *ibid*, 444 early quantitative analysis
- MAJOR, G W, *Trans Mont Med-Chi Soc*, 1890, abstract *J Laryng and Rhin*, 1890, iv, 384 (Major) sea shell nucleus
- MALCONTINE, ? 1896, cited by Seifert no nucleus found
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- MASCAREL, J, *Bull Soc de Chir, Paris*, 1852, II, 322-26 bone, ? sequestrum, nucleus, "rhinitis caseosa"
- MASINI, G, *Gaz d Ospitali, Milano* 1888, ix, 426, *Index-Cat Surg Gen* cherry stone nucleus (Hérisset)
- MAURER, ? 1889, cited by Seeligmann ? case report
- MEDAN, SUÑE Y, ? 1921, cited by Key-Åberg. case 1, prune stone nucleus, case 2, coque de pignon nucleus
- MELZI, U, *Arch ital di otol*, 1906, xvii 312-17 case 1, cherry stone nucleus, case 2, no nucleus found, quantitative analyses
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- MESZ, ? 1913, cited by Key-Åberg ? case report
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- MINK, P J, *Nederl Tijdschr Geneesk*, 1912, I, 1061-3 *Index Cat Surg Gen* case 1, cherry stone nucleus, case 2, cotton wool nucleus (Key-Åberg)
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- WERTEPROW, ? 1895, cited by Seifert no nucleus found.
- WESSING or WESSINGER, ? 1891, cited by Seeligmann and Seifert no nucleus found
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Except a few early cases, the primary reference is omitted, unless it has been verified

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ADDENDUM

Since this paper was submitted for publication, information concerning rhinoliths removed by Mr. Stirk Adams and Mr. Pavey-Smith has been received, and I am indebted to their kindness for permission to give some details of their cases, and to Mr. Pavey-Smith for an opportunity to examine his specimen.

Mr. Pavey-Smith's Case.

This rhinolith was removed from a boy aged 16, who, when aged 12, sustained an injury to his nose in a motor accident. Apparently there was then epistaxis, for which the nose was packed by gauze. When seen by Mr. Pavey-Smith, he complained of septal deviation and, during submucous resection to correct it, a rhinolith was discovered in the posterior half of the left nasal fossa. It was removed in one piece and measures $33 \times 18\frac{1}{2} \times 5$ mm. One aspect, presumably septal, is relatively flat, but elsewhere the surface is distinctly irregular. It is of light brown colour and fairly hard consistence. Mr. Pavey-Smith cut an oval window in the specimen to display the small piece of blood-stained gauze, which forms the nucleus. (The specimen is preserved in Mr. Pavey-Smith's collection of foreign bodies.)

Mr. Stirk Adams's Cases.

(a) The patient was a woman aged 31, who had had nasal trouble for only one month. A large rhinolith, approximately $1\frac{1}{2}" \times \frac{3}{4}" \times 1"$, was removed piecemeal from the right nasal passage. No nucleus was found. Much pultaceous ("caseous") material lay behind the rhinolith. Biopsy of mucosa from the mid-turbinal region showed that it was involved by a distinctly active, chronic inflammatory process, with hyperplasia and some squamous metaplasia of the respiratory epithelium.

(b) A rhinolith of approximately similar size was also removed from another patient, and no foreign body nucleus was found when the rhinolith was broken up. "Rhinitis caseosa" was absent in this patient.

CLINICAL RECORD

EXTRADURAL HÆMORRHAGE IN THE MIDDLE FOSSA ARISING FROM THE LATERAL SINUS

By STEPHEN SUGGIT

(Surgeon Lieut. Comdr. R.N.V.R.)

A HÆMORRHAGE from the Lateral Sinus, which strips up the dura mater off the floor of the middle cranial fossa and which gives rise to symptoms simulating a space-occupying lesion in the temporal lobe is sufficiently rare and disastrous in its results to justify publication.

A naval rating aged 33 years was admitted 16.10.42 with a history of bilateral intermittent middle-ear disease since childhood. The left ear had been discharging for three weeks with pain, but no pyrexia. On admission, the right ear showed a central perforation which was dry, but in the left ear there was a posterior perforation and pulsating discharge.

X-ray pictures showed that both mastoids were cellular. In the left ear the cells were small and somewhat blurred in outline.

19.10.42.—Three days after admission the left mastoid was opened. It was partly diploetic and partly cellular in type. Serous fluid was present but no frank pus. Both the lateral sinus and middle fossa were widely exposed; they appeared healthy and no unusual bleeding occurred. I did not consider *there was any indication to do more than an extensive Schwartze operation*, and the post-aural wound was partly closed with a piece of rubber glove as a drain.

Seven hours after operation the dressings became soaked. These were removed and he appeared to be bleeding from the superficial part of the wound. The rubber glove drain was removed and the post-aural wound packed with ribbon gauze soaked in eusol. Morphia gr. $\frac{1}{4}$ was given.

An hour and half after the wound had been repacked the pulse rate had fallen to 42, the patient was sleeping and no further bleeding had occurred.

The following morning he was found to be partially aphasic. He was slow and perseverating in his speech. A left sided ptosis was present: he was rubbing his left eye with his left hand and he was not moving his right leg as well as his left leg. No further bleeding had occurred, and the pulse rate was 60. The wound was dressed. There was dried blood clot in the internal auditory meatus, and on removing the ribbon gauze pack from the post-aural wound, blood welled up from the bottom. For the first time it appeared possible that the lateral sinus was the cause of the bleeding. It was readily controlled by a fresh gauze pack. There were no clinical signs of infection of the lateral sinus.

He was seen with me by Surgeon Commander R. S. Allison, R.N.V.R., in the early afternoon. The patient then presented the following neurological

Stephen Suggit

picture. He was restless and partially aphasic. Perseveration was marked. The optic discs showed no changes and there was no temporal hemianopia to coarse test. He was not sufficiently co-operative for detailed visual field examination: There was a complete left IIIrd cranial nerve palsy, a partial supranuclear paralysis of the right VIIth cranial nerve, hypotonus of the right arm and leg, absent right abdominal reflexes, and the right plantar response was extensor. A white blood cell count was 22,600 with 93 per cent. polymorphs. The blood Wassermann reaction was negative. A lumbar puncture was not done owing to the danger of producing compression of the respiratory centre.

We considered the possibility of a lateral sinus hæmorrhage having caused these physical signs, but came to the conclusion that such a hæmorrhage could not exert sufficient pressure. A provisional diagnosis was made of a space-occupying lesion of the left temporal lobe probably due to a sudden increase of cedema, following the mastoid operation, surrounding a chronic brain abscess. It was decided to wait for the cedema to subside before exploring for the abscess.

21.10.42. Two days after operation, the pulse rate was in the region of 70. There was no increase in focal signs.

22.10.42. The third day after operation, the patient's condition was deteriorating. He was more aphasic and the pulse rate was 100. No papilloedema was present. As it was known that the mastoid had been completely explored, it was considered that the brain abscess should be explored by a clean cranial approach.

At 4 p.m. that afternoon the mastoid was dressed and sealed off in the ward and the head shaved before the patient was taken to the theatre. Intratracheal gas and oxygen anæsthesia was given by Surgeon Commander R. H. Enoch, R.N.V.R., supplemented by local infiltration with novocaine. A left temporal osteoplastic flap was made and an incision made in the dura. The brain was suffused and purplish red, and under tension. No abscess could be felt or entered with the blunt exploring needle. The patient's condition did not permit of further exploration and the osteoplastic flap was replaced.

The patient died twelve hours after this operation. Post-mortem examination by Surgeon Commander J. S. Elliot, R.N., showed extensive extradural clot occupying the left middle cranial fossa. The dura was completely stripped from the floor of the middle fossa. The upper level of the clot did not reach up to the level of the hinge of the osteoplastic flap. A softening of the lateral sinus wall was found through which a probe passed into the blood clot. No other source of hæmorrhage was found and no brain abscess was present.

I am indebted to two colleagues for reports of similar hæmorrhages. In 1917 during the last war in France, Mr. Watkyn Thomas³ saw a man who was brought into hospital a few hours after injury, having fallen out of his bunk in a ship. There was a large bruise over the *right* mastoid region. He was semi-conscious. There was on the *right* side paralysis of the VIth cranial nerve, facial weakness and loss of abdominal reflex, on the *left* side some weakness of the arm. Both knee jerks were increased and both plantar responses were extensor. The pulse rate was 50, and an hour later 46, with a systolic blood pressure of 150 mm. Hg. The wound was explored. There was no sign of

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injury to the outer table, but when a disc of bone was removed, a depressed fracture of the inner table with a tear in the wall of the lateral sinus and a large extradural clot was revealed. The rent in the lateral sinus was patched with a strip of muscle and the wound was closed. The patient made a complete recovery.

Professor F W Kobrak² saw a case of "perisinus hæmorrhage", similar to the first one here described, in Jansen's clinic in 1904. It occurred in a cook aged 45. It was the only case Jansen had ever seen.

This complication of lateral sinus hæmorrhage is rare. Its importance lies in the realization that it *can* occur. It is suggested that the mechanism by which it arises is an obstruction of the distal or cardiac end of the lateral sinus by clot, with free bleeding from the proximal or cranial end. The essential features which should lead to the correct diagnosis are the sudden occurrence of signs of compression of the temporal lobe and a marked and sudden slowing of the pulse, following operation on, or injury to, the mastoid. In the first case the pulse was 42 and in the second 46. Unfortunately there are no details of the third.

An interesting clinical sign in the first case was complete homolateral oculomotor paralysis. R S Allison and J E Morrison¹ have described a case of left temporal lobe abscess in a child in which "the pupils were dilated, immobile and unequal, and the left greater than the right, but otherwise the ocular movements were full and there was no nystagmus". In this case a part of the uncus and of the hippocampal gyrus of the same side had been driven downward through the incisura tentorii. "The pupillary abnormalities probably resulted from pressure of the herniated uncus on the oculomotor nerve". It is suggested in the first case described that a similar mechanism caused the complete homolateral oculomotor paralysis.

If in case I the supposed cerebral abscess had been explored by the trans-mastoid route instead of by a craniotomy, the true state of affairs would have been discovered. Those who prefer to explore every temporal lobe abscess by the transmastoid route may consider that this case is evidence in their favour. I do not agree. The error was an error of diagnosis, not an error of surgical approach.

I am indebted to Surgeon Rear Admiral H St C Colson and to the Medical Director General of the Royal Navy for permission to publish this case.

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SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

December 4th, 1942

President—V. E. NEGUS, M.S.

Discussion on the Technique of Radiotherapy

B. W. WINDEYER

THE effect of X-rays and gamma rays upon tissues is a destructive one and if a dose of sufficient magnitude is given to any tissue necrosis will be caused. There is, however, a selective damaging effect. Some tissues are destroyed by a smaller dose than are others, and the whole object of radiotherapy in the treatment of malignant neoplasms is to effect the destruction of the tumours *in situ* with a minimum of damage to the surrounding tissues. There is a margin between the dose necessary to cause destruction of malignant cells and that which will cause irreparable damage to normal tissues. The width of this margin is affected by the resistance to radiation of both the cells of the malignant tumour and of the normal tissue. If this margin is wide the neoplastic tissue is easily destroyed while the normal tissue remains comparatively uninjured. In such a case the neoplasm is said to be radiosensitive. If, on the contrary, the margin is small the dose necessary to destroy the neoplastic tissue may approximate to that which will destroy or cause irreparable damage to the normal structures and in these circumstances the neoplasm is said to be radioresistant. The object of all variation in radiotherapeutic technique is to increase the width of this margin as much as possible and so bring a greater number of neoplastic conditions into the radiosensitive category.

Some growths are naturally radiosensitive. Such are lymphosarcoma, lympho-epithelioma and the majority of basal-celled carcinoma. The majority of neoplasms are, however, not naturally so radiosensitive and their successful treatment demands special variations in technique. The variations adopted are mainly of two kinds: (a) alterations in the rate at which radiation is delivered and the length of time over which the treatment is spread, and (b) alteration of the character of the radiation.

The three main methods which have been employed in applying radiotherapy have been: (a) Multiple small dose technique. (b) Single massive dose technique. (c) Fractionated technique.

(a) The first, multiple small dose technique, is of value, and the treatment of choice, in dealing with inflammatory conditions, but should be mentioned

in connection with the treatment of malignant disease only to be condemned, as it has no place in any attempt at curative treatment of malignant neoplasms. The individual suberythematous doses given at intervals of about a week or longer do not have a cumulative effect on the rapidly dividing cells of the neoplasm. Some may be destroyed, but the majority which survive appear, in their successive generations to acquire progressive immunity to the effects of radiation. The damaging effects on the infrequently mitosing normal tissues are, however, cumulative and there is the risk of causing marked fibrosis or necrosis of the area with the active and resistant neoplasm still present.

(b) The single massive dose technique is certainly of value in some conditions, more especially in superficial localized growths which are radiosensitive, such as the majority of the common malignant diseases of the skin. It does however, cause a very marked reaction both local and general and is not suitable for extensive, deep seated and radioresistant lesions.

(c) The fractionated single course of treatment is most widely applicable in the X ray treatment of malignant disease. It has been found that, owing to the recuperative powers of the tissues if radiation is spread over a period of days or weeks the tissues will stand a greater dose than if the treatment is given in a short period of minutes or hours. Moreover, it has been found that by spreading the treatment out in this way certain malignant tumours can be destroyed without undue damage to normal tissues whereas this could not be done with a single massive dose. Regaud propounded the theory that by spreading the total period of treatment over a period of several days up to two or three weeks, more malignant cells were irradiated in their most vulnerable stage of mitosis, whereas the normal tissue cells of slower reproduction would not be so affected.

When radium needles are inserted into the tissues the prolongation of the total time of treatment can be accomplished by using needles of low intensity and subjecting the tissues to a continuous irradiation. With X rays this is not practicable but the total dose can be given in individual fractions on successive days.

The treatment must, however be designed as a single course in which the daily fractions of the total treatment have a cumulative effect. If these fractions are too small and the course of treatment is spread out over too long a period of time there will cease to be a cumulative effect on the cells of the neoplasm which will remain active and become immunized to the effects of radiation. There will, however, still be a cumulative effect on the normal cells, particularly those of the connective tissues. In fact, the technique will have become the inadequate one of multiple small doses and therefore, the total period of treatment should not be in excess of thirty to thirty five days in most cases. In many cases if an adequate total dose can be delivered in a shorter period, say ten to twenty days without causing undue local or general reaction in the patient, there are obvious economic advantages.

Experimental work has produced contradictory results. There is evidence that protraction of individual treatments causes less reaction in skin and subcutaneous tissues, thus allowing a greater dose to be given, but it has not yet been proven whether the destructive effect on the underlying tumour is not also less marked with protraction. Further clinical experimental work is

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being carried out both with the use of low and of very high dosage rates. It is obvious that many more patients can be treated on one X-ray tube in a working day with a dosage rate of 50 röntgens per minute than if it is limited to 5 röntgens per minute.

With the use of a single beam the dose in the tissues must be limited by the tolerance of the skin and to obtain adequate irradiation of any internal tumour when its radiosensitivity is not much greater than that of the skin it is necessary to use more than one skin field, directing the beams so that they cross fire on the tumour and by their summative effect produce a dose at the tumour level which is as high as, or higher than, that received on each skin field.

A different quality of X-ray beam is indicated for the treatment of individual lesions, depending largely on their situation, whether superficial or deep in the tissues. There is no proof of any specific, selective, biological action dependent on wave-length but the effects observed are due to the amount of energy absorbed at any particular point. In superficial lesions which do not extend deeply into the tissues the aim is to deliver a heavy dose to the volume of the tumour in the first one or two centimetres' depth of tissue and to avoid injury to the subjacent normal structures. For this purpose X-rays generated at low voltage, i.e. 60 to 100 kV., are most appropriate and have a considerable field of usefulness. The contact therapy tubes designed for this purpose are especially convenient not only for superficial skin neoplasms but also for non-infiltrating primary growths of limited extent in accessible situations within the buccal cavity such, for example, as the buccal surface of the cheek, floor of mouth, palate or anterior pillar of the fauces. X-rays generated at high voltages, i.e. 180 to 250 kV., are most appropriate for the great majority of malignant tumours treated in laryngological practice as they are situated at no great depth below the skin surface and a high tumour dose can be obtained by the use of multiple fields correctly planned and accurately directed. Super-voltage X-rays, i.e. those generated at kilovoltages in excess of 250, appear to be of no particular advantage in this field of practice except in such lesions as carcinoma of the oesophagus in its thoracic extent, where the lesion is at least 10 cm. from the skin surface and where it is more difficult to obtain an adequate tumour dose with multiple fields without irradiating the lung tissue to some extent.

In each case the first step is to plan the treatment in detail and with accuracy. The exact site, size and limits of extension of the primary lesion and of any metastases must be noted and related to surface markings. The choice of appropriate fields, their number, size, position and direction must be worked out in association with the physicist of the radiotherapeutic department. The aim should be to obtain a sufficiently large dose to the whole extent of the tumour together with the irradiation of a minimum of normal tissue, and to avoid damage to organs which are particularly sensitive to the effects of radiation. Fields should be chosen which give the shortest distance from the skin surface to the lesion. Care must be taken that the volume of the tumour is irradiated with a homogeneous dosage throughout its extent and that the region of maximum dosage in the whole volume irradiated is accurately centred on the tumour.

If the area is to be treated by one anterior and two lateral fields, these must be directed to a point slightly behind the larynx in order to obtain a

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homogenous distribution of dosage on the larynx itself. If directed at the larynx itself the point of maximum dosage will be in front of the lesion and may precipitate necrosis of cartilage with underdosage to the tumour.

Some conditions need treatment by a few large fields. Such are tumours which have widespread regional metastases or are likely to metastasize and are radiosensitive. Others, in which group are the majority of squamous-celled lesions, need multiple smaller fields in order to obtain a high tumour dose, whilst avoiding excessive damage to normal tissues. With small fields particularly, accurate beam direction is essential.

There is one method of beam direction which may not be mentioned by other speakers, but which has been found of value in the treatment of some lesions. Many primary lesions of the tongue, floor of mouth, palate, tonsil or pillars of the fauces are sufficiently small to be irradiated adequately by a field $2\frac{1}{2}$ or 3 cm in diameter. Although the diameter of the lesion may be small there may be considerable infiltration and the low voltage contact therapy tube may not have a sufficient percentage depth dose to ensure adequate dosage to the deepest part of such a tumour. In such cases an intrabuccal applicator can be used with the ordinary high voltage X-ray tube. Accuracy of beam direction can be ensured by having an aperture in the side of the applicator and using an electrical nasopharyngoscope as a periscope to see that the lesion is in the centre of the field.

It is not yet known what dose is required for each of the various types of tumour. It has not been widely confirmed that there is an appreciable difference in radiosensitivity between the various groups of squamous carcinoma.

Success does not depend on the actual dose delivered to the neoplasm. The reactions of the normal tissues to that dose are of the greatest importance not only because of the possible development of oedema and necrosis but in the actual process of destruction and the disappearance of the neoplasm.

Radiotherapy for malignant disease in the mouth or throat causes severe local reactions which are painful, cause difficulty in swallowing, even of saliva, and depress the general condition. Radiotherapy is no easy alternative to surgery for the patient, but is an ordeal demanding the utmost co-operation and determination from him.

CONSTANCE WOOD

Technique of teleradium treatment—This form of therapy is called by various names—teleradium treatment, treatment by radium bomb, or by radium pack—its continental names are telecurietherapy and Radiumfernbestrahlung, while radium beam therapy is the term commonly used in Great Britain. Treatment by radium beam involves the use of radiation emitted by large quantities of radium of the order of 2 to 10 gm.

The technique and teleradium apparatus described here is that designed at the Radiotherapeutic Research Unit of the Medical Research Council.

The use of tungsten alloy in the construction of the 10 gm teleradium apparatus instead of lead enables this unit (Fig. 1) to be much better protected than earlier types of teleradium apparatus and at the same time to be less bulky.

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even though it contains much more radium, the largest quantity in fact used in any one unit in the world. The chief features in its design are that it affords increased protection to both patients and staff and also allows of much greater flexibility in treatment than was formerly possible.

The increased protection afforded when the alloy is used is important because when radiation received by the patient in all parts other than the cancer-bearing area is reduced to a minimum undesirable constitutional effects are avoided. Interchangeable applicators fitted at the treatment end of the unit enable areas of treatment of different sizes and shapes to be used and so permit of greater flexibility in treatment. The sizes of the applicators used in carcinoma of the mouth and throat are 5 cm. circle, 8 cm. circle, and 6×8 cm. rectangle. One of the most important advances in this unit is the perfection of pneumatic transference, first suggested by Sievert. The radium is blown by air pressure through a tube to and from the storage safe to the unit, thus no handling of the radium is necessary and all exposure of the staff is avoided.

In radiation treatment, especially with such small ports of entry as we use in the treatment of carcinoma of the mouth and throat, there is considerable difficulty in directing the beam of rays accurately at a tumour situated at some depth below the surface. When such small fields are used and the unit is set by eye, there is a possibility in some cases of missing the growth altogether. One of the causes of failure in radium treatment with small fields has been this inability to direct the beam accurately.

Various methods to obtain accurate aim were tried, and finally a caliper instrument as devised by Dr. Green was adopted. The instrument consists of a pointer arm which moves out along the central axis of the beam. The radium unit may be likened to a big gun: the beam of rays emerges from the mouth of the gun, the pointer of the caliper instrument is placed on the far side of the object to be struck and in line with it, and the scales mounted in relation to the pointer arm show the degree of accuracy of the shot and the direction in which correction must be applied. When using the instrument the small electric light bulb on the end of the pointer arm (indicated by arrow on Fig. 1) is placed on the tumour within the mouth. The direction of the beam is then adjusted until the location scales read zero. The central ray is now passing through the centre of the tumour and the radiation field is uniformly distributed about it. The site of exit of the beam is in a direct line between the port of entry and the tumour. This site of exit, the emergent ray, is marked on the patient, and each successive treatment can now be repeated with precision. The error in directing the beam by eye is in this way eliminated. If the direction of the beam is to remain constant, it is essential that the patient does not move throughout the course of treatment. This is ensured by a simple stabilizing mechanism consisting of a number of padded clamps on universal joints, which maintains immobilization of the patient.

The three scales on the caliper instrument described above may be used to define the position of any desired point in the tissues. The position of this point can then be located on the dosage rate charts and hence the number of röntgens per hour at this point can be calculated. It is thus possible to measure the total dosage from all ports of entry for all planes.

An attempt is made to improve the general condition of all patients under-

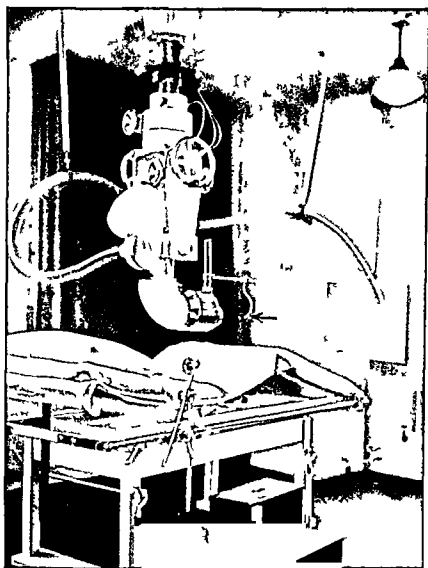


FIG. 1

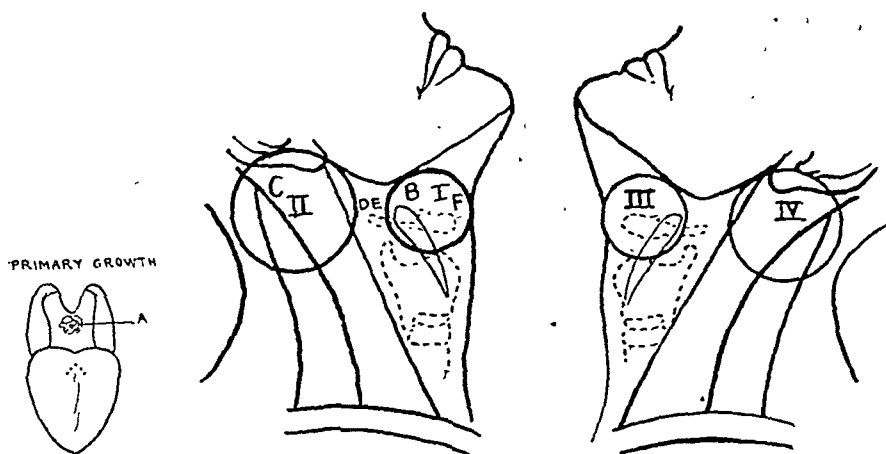
Ten gramme radium unit with pneumatic transference of radium between unit and lead storage safe

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fields on either side of the neck, Ports I and II corresponding with Ports III and IV.

Certain key points are selected at which it is desired to know the dosage. By determining the dosage at these points for the particular combination of ports used, the strong and weak regions in the field of radiation are brought out, and hence the delivery of dosage can be accurately controlled. The points chosen in this example are indicated in Fig. 2. A is the point on the primary growth; B, C, and D are the points in the gland area; and E and F are the skin points selected.

FIG. 2.



Port I—Right submaxillary port, 5 cm. in diameter.
Port II—Right superior cervical port—8 cm. in diameter.
Ports III and IV are symmetrical with Ports I and II.

Points at which dosage is desired :—

- | | |
|---|---|
| A—dose to primary growth. | D—dose to glands 2 cm. deep between Ports I and II. |
| B—dose to glands 2 cm. deep to Port I. | E—dose to skin between Ports I and II. |
| C—dose to glands 2 cm. deep to Port II. | F—dose to skin over Port I. |



Emergent Rays : E1—position of emergent ray for Port I. It is 5 cm. behind the external auditory meatus on Reid's base line and 7.5 cm. vertically upwards from this point. E2—position of emergent ray for Port II. It is at the junction of the upper and middle thirds of the sternomastoid.

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Readings on the three scales of the caliper are then taken through every port of entry for each point at which it is desired to know the dosage. These are recorded as in Table I.

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* TABLE I—CALIPER MEASUREMENTS FOR POINTS A, B, C, D, E, F
Caliper Measurements

Port No	Scale	Point A	Point B	Point C	Point D	Point E	Point F
I	VS	1 0	0 0	2 0	3 0	2 0	0 0
	HS	5 5	2 0	2 0	1 0	0 5	0 0
	CS	0 0	0 0	5 0	3 0	4 5	0 0
II	VS	1 0	0 5	5 0	3 0	3 0	1 0
	HS	5 5	2 5	8 5	6 5	6 5	2 5
	CS	0 0	3 5	5 0	5 0	7 0	6 0
III	VS	0 8	1 8	0 0	0 8	0 8	1 8
	HS	5 9	3 4	2 0	0 9	0 9	3 4
	CS	1 0	3 0	0 0	3 0	4 5	5 0
IV	VS	0 8	1 3	0 2	0 2	0 2	1 3
	HS	5 9	8 9	11 4	11 4	11 4	8 9
	CS	1 0	4 0	2 0	3 0	5 0	5 0

VS = Vertical Scale on Caliper
HS = Horizontal Scale on Caliper
CS = Circular Scale on Caliper

The caliper readings are then referred by calculation to the dosage rate curves, in this way the dosage rate at each point is determined and recorded as in Table II. The dosage is controlled by varying the time of exposure through the different ports

* TABLE II—DOSAGE RATES AT POINTS A, B, C, D, E, F, IN r PER HOUR

Port No	A	B	C	D	E	F
I	155	307	65	110	65	485
II	155	170	25	45	25	50
III	130	185	285	320	275	165
IV	130	85	60	60	60	75

* Tables reproduced from *Brit J Radiol*, 1937, v, 89 by permission

The daily progress of the dosage at each of the points is recorded and finally the dosage delivered is plotted on a graph (as illustrated in Fig 3) which shows the rising total in rontgens to the primary tumour, glands and skin on successive

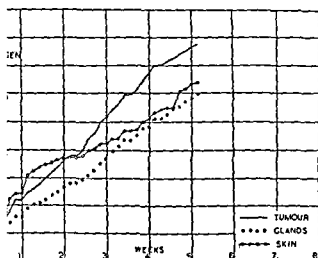


FIG 3—Dosage

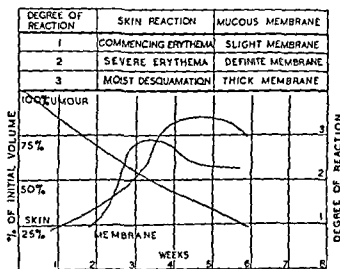


FIG 4—Reactions

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days of treatment. Varying dosage levels have been tried. It has been found that the best results were obtained when approximately 6,000 to 7,000 röntgens were delivered to the lesions in forty-two days. Two treatments of twenty minutes each are given daily. It was considered desirable to divide the treatment in this way because a short treatment time is less tiring for the patient and there is a greater chance of his remaining absolutely still.

The general response of each patient to treatment is recorded in the form of a graph which shows the response of the constituents of the blood, blood-pressure, pulse, and weight. An analysis of the blood-counts showed that treatment of the type described results in a fall in the total leucocytes due almost entirely to a diminution of the lymphocytes. There is a loss of weight in most patients during treatment and, as already mentioned, great attention has been given to the nutrition of the patient both during and after treatment.

The local reactions produced by the treatment are recorded in Fig. 4.

The response of the tumour and glands to the treatment and the time of appearance of the mucous membrane and skin reactions are recorded in this way. The time of appearance of these reactions varies, but usually a slight yellow membrane appears on the primary growth about the end of the first week. This spreads and becomes a thick membrane about the fourth week and then slowly diminishes and disappears.

The reaction on the skin usually develops later than that on the mucous membrane. It frequently does not occur before the third or fourth week. It begins as a slight erythema, increases to a severe erythema and then the skin often becomes deeply pigmented and the epidermis is shed as a dry desquamation. In cases where the skin reaction is more severe, supervening on the erythema a few blebs appear. These coalesce and then finally the epidermis peels off leaving an area of moist desquamation. It has been found better not to cover this by any dressing, thus avoiding the trauma which would be caused in removing it. It has been treated either by acriflavine or 2 per cent. gentian violet which provides a dry crust under which the skin readily heals.

Paintings of growths in the hard palate, posterior third of tongue, soft palate, tonsil, pharynx and larynx were shown, illustrating the lesions, before and after treatment by radium beam. Fig. 5 shows the isodose contours obtained by irradiating the larynx with two opposing fields—an equalized dose is obtained throughout the whole of the laryngeal area. Diagrams of the ports of entry used and graphs depicting the dose delivered and the response to treatment in each case were also exhibited.

RALSTON PATERSON

Radiotherapy in pharyngeal and laryngeal cancer.—This paper deals with the technique of radiotherapy, as applied to *pharyngeal* and *laryngeal* growths, with emphasis on radium.

There are two main types of malignant growth in pharyngeal and laryngeal cancer:

(1) *Squamous-celled carcinoma (or epithelioma).*—This can be found arising at any point on the mucous lining from post-nasal space to cricoid region.

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(2) *Reticulo-endothelial growths*.—These are radiosensitive and are chiefly found in the post-nasal space, the tonsil and tonsillar bed, and the base of the tongue.

The distinction between carcinoma and the reticulo-endothelial growths is of vital importance as the principles of treatment are different. Where any doubt exists, and certainly in every case under 50 years, and in post-nasal and tonsillar growths, a biopsy before treatment is essential.

Squamous-celled cancer is the more frequent. Exact delimitation is of importance because the fundamental need of treatment is to irradiate the smallest possible volume which will yet enclose the whole tumour. The

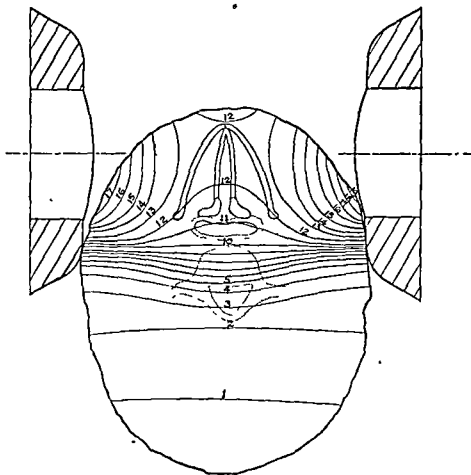


FIG 5

Isodose contours obtained by irradiating larynx with two opposing fields

smaller the volume to be irradiated, the higher the dosage of radiation which can be given. The purpose of radical radiation treatment is to give as high a dosage as will be safely tolerated. It is a good general rule that the curability of a carcinomatous lesion is approximately inversely proportional to the size of the growth. Really small growths in this field are for the most part curable if proper treatment is instituted early and is radical. Indeed, the results of treatment in what is probably the smallest internal tumour diagnosed—namely, carcinoma of the vocal cord—are excellent, because the hoarseness is such an early key symptom. This growth is curable, not because of any special radiosensitivity, but because when first diagnosed it can be treated in ideally small volume and to a maximal high dose.

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Curative therapy.—The mainstay of treatment is external radiation by X-ray or radium beam. This is in contrast to the treatment of mouth cancer. In mouth cancer accessibility makes intra-oral radium application technically easy and radium is nearly always preferable to any form of external radiation. Almost as if in illustration of the difference we find the faucial growth, in a sense, a neutral lesion in this respect—and X-rays and radium may be rated as of equal value.

Even in the pharynx and larynx, however, there are a few sites on which radium can be used as an alternative. The four good sites are these: (1) Finzi-Harmer fenestration implant for growths of the middle third of the vocal cord. (2) Sponge-rubber applicator for limited superficial growths in the post-nasal space. (3) Radon seed implant under direct vision in the oropharynx. (4) Radium-bearing collar combined with radium loaded bougie for limited growths of the hypopharynx.

With the four exceptions described, attempts at localized radium treatment of pharyngeal and laryngeal growths are better avoided.

Mention should be made of another technique for intrinsic cancer of the larynx which has been devised by Victor Lambert and T. A. Watson in Manchester. It is as yet a purely experimental piece of work. The whole ala of the thyroid cartilage is removed surgically, leaving only the inner layer of perichondrium. The larynx is given there and then a single high dose of radiation using a contact therapy plant. The wound is stitched up at once and healing is smooth. The method is too recent to report durability but the immediate results are satisfactory.

Palliative therapy.—Radiation is also of great value as a *palliative agent* alone. Radiation has a capacity for slowing up growth rate and causing partial or even temporary disappearance of a growth too large to allow permanent resolution. This results in a moderate prolongation of life and, really more important, great relief of symptoms. The dominant symptoms are dyspnoea, dysphagia, pain and occasionally hæmorrhage. All of these can be greatly relieved. The mental relief from feeling so much improved is also real. When palliation is all that is possible a very different radiotherapeutic approach is called for. Radical treatment is not appropriate. Nevertheless to get any effect at all a considerable, though far short of maximal, dosage of radiation is still required and some reaction must still be taken. The course of treatment, however, can be profitably shortened and treatment given over a period of days rather than weeks.

Reticulo-endothelial growths.—The reticulo-endothelial growths are interesting because of their great radiosensitivity. The term reticulo-endothelial covers a group of growths whose common characteristic is that they are highly radiosensitive. The pathologists give them a variety of names—lympho-sarcoma, reticulum-cell sarcoma, lympho-epithelioma, endothelioma, nasopharyngeal endothelioma, round-celled sarcoma.

In their response to radiation, these growths have two linked characteristics. They are both radiosensitive and radioresoluble. By *radiosensitive* is meant that they disappear or melt quickly under radiation. In the very sensitive the response is shown in the very first few days of treatment. A tumour which

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melts quickly does not *ipso facto* stay away. By *radioresoluble* it is indicated that with sufficient dosage, and yet such as can be given to big volumes of tissue, they not only respond at once but resolution remains complete in the treatment zone. With adequate treatment, local recurrence is very rare. They have, however, a third, a most tantalizing and unfortunate character, which deprives us of much of the advantage of their radioresolubility. They are highly malignant and have a tendency to rapid, wide and early metastasis. Localized treatment, such as has been outlined for the carcinomata, is usually futile. Big volumes of tissue have to be irradiated for what may seem limited growths. The radiologist has to think no longer in terms of 2 to 3 cm. clearance of all known growth, but of clearances of the order of 5 to 10 cm. in all directions from visible or palpable involvement. For post-nasal growths which grow through the foramina into the base of the brain fields must go upwards well into the cranial cavity. Downwards it is seldom wise to irradiate less than the whole length of the neck down to the clavicle, even in early cases. If there are already a string of nodes down the neck, or down both sides of the neck, the irradiated zone should go right down into the mediastinum.

High percentages of cure depend on getting the disease before general dissemination and in the good cases the cure rate is high if they are treated radically in this way. The dose stated in röntgens is considerably less than with small field therapy but it is still radical, as the whole of a large volume of tissue is raised to the limits of tolerance. The reaction is marked both in the skin and in the mucosa. Swallowing may be painful for about two weeks at the height of the reaction, but the patients are often young, the cure rate is good, and radical therapy well worth doing.

There is no satisfactory radium alternative for these growths. Academically, the use of a large neck pack might be justified under exceptional circumstances. The need for wide field therapy is so great that a growth already partially treated under a wrong diagnosis by local radium, or by small field therapy, and found on histological examination to be of this type, should be transferred at once to the wide field plan. Spectacular response on the part of a supposed carcinoma of the post-nasal space or carcinoma of the tonsil, is a warning that diagnosis and treatment need reconsideration.

In conclusion, one general point requires special emphasis. When radical surgery is contemplated in the treatment of cancer in any part of the body, no one spares elaborate preparation and care. The availability of an expensive and properly staffed operating room is almost taken for granted. The operation itself may take hours. Radical radiation therapy aiming at cure ought nowadays to be an elaborate process with the same need for previous thought and preparation as a radical surgical operation. The X-ray exposure is merely one incident in the process. Much previous planning and charting is needed. Many cases require special applicators to be built, calling for a workshop known as a mould room.

N. S. FINZI suggested to Dr. Paterson that if he got late failures with the present method he was using by applying low-voltage X-ray therapy to the larynx, he should try a higher voltage X-ray therapy. It might still be a good method, only that the voltage might be too low. If there were recurrences after contact therapy he should try a high voltage with the same methods.

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There were technical difficulties with short distance high-voltage therapy which did not obtain with low-voltage, but they could be overcome.

He differed from Dr. Paterson in only one respect, namely, with regard to extrinsic laryngeal carcinoma, in which field he had had no prolonged success. He asked whether Dr. Wood had had any experience of intrinsic laryngeal tumours treated with teloradium. He was not sure whether the procedure could be carried out safely without fenestration. Coutard in his X-ray treatment of these cases had some cases of necrosis of cartilage. Sometimes these growths were very septic, and the necrosis was due to an infection which was probably never completely eradicated although the tumour itself disappeared.

There was one other method which he used in the treatment of laryngeal cases, namely, the relatively wide field treatment with its overlapping areas. This had been misused by others who had taken wider areas than he had ever done. He used overlapping areas and six angles with the idea of getting homogeneous irradiation.

FRANCIS ROBERTS said that he agreed with what Dr. Paterson had said about extrinsic tumours. In those that he had treated, the glands were already involved when first seen and nothing could be done except palliative treatment. As regards intrinsic tumours, the case was very different, and nothing gave him greater gratification than to find that the small fields which he had introduced had been so widely adopted. But these fields of 5 cm.² or 3 cm.² he had now abandoned because they were too large and clumsy. His present method which he had used for six years depended upon the fact that no organ in the body had its position so closely defined or was subject to so little variation. He used seven 5 × 1 cm. fields with the long axis vertically going round the larynx, and to each of these fields he gave about 700 r (one field per day). The cycle was repeated in the following week, the total surface dose being from 10,000 to 15,000 r. It might be said that these fields, the disposition of which he showed in lantern slides, were unnecessarily long, but they had the advantage of covering the tumour below and above, and they did save the bother of localization in one plane. He had, however, since gone in for still smaller fields, and he showed an arrangement of seven 1.5 cm.² fields, and another with ten 1 cm.² fields in two rows of five. Thus each beam was almost limited to the tumour itself.

He first used 200 kV. with 1 mm. Cu filter, then changed to 200 kV. with 1 mm. Al and now used 120 kV. with 1 mm. Al. Although this last appeared to be a retrograde step it proved equally effective and had the merit of being much cheaper.

The great advantage of his method was the entire absence of any serious reaction of which so much had been heard. The three cases which he had treated five years ago were still free from recurrence.

J. JACKSON RICHMOND described briefly the principles of a new method of teloradium treatment of intrinsic laryngeal cancer. He thought that it was in the treatment of malignant tumours of the larynx that teloradium had one of its chief applications. To obtain homogeneity of dosage precise alignment of the fields was required. In this region the angulation required would be highly critical; any relatively small deviation from the directions of the axis beams would cause gross disturbance to the dosage uniformity with consequent risk

of excessive irradiation of the laryngeal cartilages. Consequently it would be preferable to have some arrangement whereby a volume which was relatively uniformly irradiated could be set up, and the patient, or rather the lesion, placed inside this zone. Working in collaboration with Dr. Wilson of the Department of Physics of Westminster Hospital, he had designed a cervical frame which could be accurately applied to the appropriate landmarks of the neck to give the required conditions of irradiation.

Professor Windeyer had shown the dose contours obtained from the employment of three 3.5 cm. circular fields with the 4 Gram radium unit. The most striking fact was that the optimum dosage distribution resulted when the axis beams of the two lateral oblique fields were directed posterior to the lesion. Consequently the framework was so made that the radium bomb head was held in a pre-determined position, and as the actual zone of irradiation set up must be always constant it was unnecessary to employ the more elaborate methods of beam direction, excellent as they were.

With this technique it was *only necessary* to adjust the frame to the patient's neck accurately, and the lesion would automatically fall into the focus of uniform irradiation.

D. W. SMITHERS mentioned the value of a series of tomographs as a means of localizing the size, shape and position of tumours.

V. LAMBERT showed a colour film illustrating the technique of the surgical exposure for contact X-ray treatment of the larynx. This was referred to in Dr. Paterson's paper. The film was made by Mr. James Weeks, late of the American Ambulance Unit in Great Britain. Mr. Lambert said that the surgical exposure shown so briefly on the film took anything from twenty-five to thirty-five minutes. The tube was then placed in position by his radiological colleague, and the irradiation occupied about another half-hour. The procedure had been carried out in sixteen cases. There had been no operative mortality. One death had occurred from recurrence and one case showed *doubtful recurrence (more probably necrosis)*; also one death from an *intercurrent disease*, though the larynx itself was healed. Nothing was claimed for this treatment at the moment, because there had not been enough cases, but if it was successful it was safe to predict that an attempt would be made to utilize it for cases in which both sides of the larynx were involved.

B. W. WINDEYER, in reply, said that the classification of squamous carcinoma had so far given very little help in questions of dosage. They were constantly finding cases where very undifferentiated growths seemed to be more resistant than others which were well differentiated. He was aware that statements had been made quite frequently in the past that well-differentiated growths should not be treated by radiotherapy because they were going to be unresponsive. He did not think that was true. There were possibly among the cases which had been cured quite a large proportion which had had well-differentiated growths.

He thought that it was not yet possible to make an authoritative statement as to whether teleradium in any situation was preferable to X-rays. At his hospital they had been working with teleradium alongside X-rays since 1932. His opinion so far, though not as yet backed by statistics, was that there was no definite advantage. What could be obtained by teleradium could be

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obtained, given the proper technique, by X-rays. He supported Dr. Smithers as to the value of tomography in finding the exact size and limits of laryngeal and pharyngeal growths.

CONSTANCE WOOD, in reply, said that Dr. Finzi had spoken about necrosis as a possibility after the treatment of intrinsic laryngeal tumours with teleradium. She thought that with carefully planned fields it was possible to avoid this sequel.

As to the relative value of teleradium and X-ray therapy in treatment of carcinoma of the mouth and throat an investigation was at present being carried out at the Radiotherapeutic Research Unit in which a series of cases were being treated by X-rays using exactly the same technique as had been used in the treatment by radium beam. The results would provide a basis for an unbiased comparison of the relative merits of the two methods.

RALSTON PATERSON, in reply, said that in the technique which Mr. Lambert had described the radio-therapeutic exposure took about half an hour. Both deep X-ray and contact therapy could be used in treating the larynx in this way but, for the present, results of contact therapy only were being reported. The treatment was in its experimental stages, but out of eleven cases, eight were obviously well, though whether the cures would be durable or not only time would prove. The question of assessing beam therapy against deep X-ray therapy was one in which it was very difficult to arrive at any method of assessment. The main thing was to get an adequate dose of radiation to the whole involved area and any method by which that was achieved was the right way. There was an academic argument in favour of bomb therapy but, if X-rays were as effective, then on economic grounds that method had advantages.

OBITUARY

HARRY LAMBERT LACK, M D, F R C S

HARRY LAMBERT LACK, who died on February 14th, began his medical studies at King's College Hospital at the age of 17. After a brilliant career as a student in which he carried off most of the possible prizes, he became house surgeon and pathological assistant to Watson Cheyne. Lister had retired and Cheyne was chiefly responsible for carrying on the methods which revolutionized surgery. Cheyne and Lack worked in close association, and a lasting friendship was established.

Early in life Lack undertook many original investigations mostly of a pathological nature. He retained interest in pathology all his life, and made frequent use of the microscope as an aid to his clinical work.

After leaving King's he became Resident Medical Officer at Paddington Green Children's Hospital and then at the Throat Hospital, Golden Square. Later on he joined the Staff of both institutions. He was subsequently elected Surgeon to the Throat, Nose, and Ear Department at the London Hospital and at this Hospital he worked for many years with untiring energy and devotion.

In 1899 Lack was awarded the Jacksonian Prize for an essay on "The Pathology, Diagnosis and Treatment of Inflammatory Affection of the Nasal Sinuses and Air-cells". This essay was revised, additional sections added and in 1906 his book *Diseases of the Nose* was published. Every chapter shows signal ability on the part of the author in carrying out investigations anatomical, pathological and clinical, and as a critic of the work of others. The book remains to day, after the lapse of twenty seven years the most scholarly treatise on the subject in the English language.

Lack was a very good surgeon, and showed himself equally at home in such a delicate manipulation as the removal, under indirect vision, of a nodule from a vocal cord and in such a major procedure as extirpation of the larynx. I think I am right in saying that previous attempts at the London Hospital to perform this operation had been unsuccessful.

He saw the merits of the direct methods of examining the larynx, lower air passages and œsophagus, he soon became expert with the new technique and he was very skilful in removing foreign bodies from the lungs. Another new idea demonstrated by Naegelschmidt in 1910, was the treatment of malignant growths by diathermy. Lack was the first person to employ this method at the London Hospital, where subsequently many patients were treated by him and his associates with a large measure of success.

He made many important contributions to his specialty. These included investigation into deformity of the upper jaw and teeth resulting from nasal

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obstruction, the nature of fibrinous rhinitis, and its relation to diphtheria, and the causation of congenital laryngeal stridor.

He was an accurate observer, and his deductions were always logical, but it was his originality that made his work so valuable.

He had a very kind heart, and delighted in giving pleasure to others, his friendship was something to prize. I worked with him for many years, and have nothing but pleasant memories of the many hours we spent in close association.

Lack, although trained at another institution, was truly loyal to the Lonsdale Hospital, which held first place in his esteem. In addition to his professional interests he had many others, such as literature, old furniture, gardening, birds and golf.

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DEAFNESS IN INFANCY AND EARLY CHILDHOOD

By IRENE R EWING* (Manchester)

SINCE the clinic for the deaf was established in 1934 at Manchester University the number of infants and children suspected of deafness who have been referred by otologists and other doctors has steadily increased. Gradually we have been able to collect a considerable amount of data about the behaviour of young deaf children and their response to certain situations and tests. In a number of cases this data has been compared with *Gesell's norms of development for infants and pre school children* who have normal capacity to hear. It was necessary, therefore, to adopt some at least, of the terms used by Gesell. It seemed wise also for the purposes of comparison to use the four heads under which he classifies the different items of behaviour in children.

For this paper the records of thirty unselected deaf children have been analysed. These patients were all referred to us by otologists or other doctors. Ten of the children were under the age of two and twenty were between the ages of two and three at their first visit. The youngest was twelve months old. All of these infants visited our clinic on more than one occasion, the majority have been in touch with us ever since. In tests of hearing made through play three of the ten infants under the age of two and eleven of the two and three year-olds failed to respond to any form of sound stimulation. The other sixteen children all gave definite proof of possessing at least a small island of hearing. Twenty eight of the children were reported to have been born deaf, one to have become

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deaf at the age of one from measles and one from meningitis at the age of five months.

Motor Development

All the sixteen children with islands of hearing were either seen to walk or were reported to have walked alone by the age of eighteen months. Two walked alone at twelve months and four at fifteen months. Gesell gives a credit mark of A+ for walking alone at twelve months and a credit mark of C for walking at eighteen months. It would appear, therefore, that walking in children who are severely but not totally deaf is not seriously retarded. By contrast the figures for the totally deaf group are strikingly different. Only two of the fourteen reach Gesell's credit mark of C. None of the others walked before the age of nineteen months. Two are reported not to have been able to sit up alone before the age of eleven months. Gesell gives from six to nine months as the common age for this. Another two children did not walk alone until the age of two years. Slurring of the feet and very clumsy walking were noted in five of the totally deaf group who were nearly three years old. It is recorded of Mary, totally deaf, one year ten months old, "She overbalanced and fell seven times in four minutes," and a fortnight later, "She fell five times in three minutes. She staggers and over-balances if she attempts to move quickly." A few days before her second birthday it is recorded, "Mary only fell twice in twenty-five minutes to-day."

Adaptive Behaviour

Gesell defines adaptive behaviour as "General capacity to exploit the environment or to make adjustments to imposed situations", e.g. dangling a ring; reaching for a spoon; block building. In the clinic our first aim is to rouse a child's interest in play material, and at a later stage to win his co-operation. All of the thirty, except two of the totally deaf children, achieved Gesell's norms for children of the same age with normal capacity to hear. Retardation was observed in manipulation of play material in only two of the totally deaf children. Seven of the two-year-olds completed items named by Gesell as suitable for three-year-olds. From our observations and tests it appears that neither severe nor total deafness in young children causes backwardness in adaptive behaviour which is independent of communication.

Language

Under the term language Gesell includes vocalization, speech and auditory comprehension. No child among our group of thirty has enough hearing to enable him to learn to talk or to use or comprehend any words at all. No comparison can be made therefore under this head between

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deaf children and those who hear. We have, however, made a close study of the young deaf child's use of voice, of his ways of making his wants known and of his ways of trying to comprehend what other people want him to understand. Twenty-eight of the thirty severely or totally deaf children were heard in the clinic or were reported by the parents to use their voices naturally in babyhood. Two mothers only reported that their children had always been very silent. Both of them were totally deaf. We have made gramophone recordings of the voices of a number of our young patients when they were at play. They were not specially selected for this purpose. The voice of a one-year-old deaf child is not characterized by any abnormalities. His vocal play is rhythmic, and there are natural variations in loudness and in pitch. The early vocal play of all the children is natural. There are variations in pitch and loudness such as occur in the vocalization of children who can hear, but I think there are fewer variations. There are trills in laughter and modulations of voice indicative of the emotion being experienced. Contentment is shown by quiet rhythmic tones. * Urgent desire by louder and more strident tones. It is not until after the age of about eighteen months that the totally or very severely deaf child, if left to himself, tends to lose interest in using his voice, and to become more and more silent unless he is disturbed emotionally. He usually makes a noise when he is angry or afraid. In our records of untrained deaf children between the ages three and five it is noticeable that voices have become strained and ugly and that the quality of their vocalization is abnormal. At the time when the deaf child begins to use his voice less he also begins to make his wants known by pulling, pushing, grabbing, pointing and gesture. When people around him respond in the same way movements and gesture soon seem to take the place of the child's earlier use of voice. This change over from vocal expression to gesture is understandable in the circumstances but at the same time it is to be deplored. It constitutes a sharp break in the march of events which normally leads to speech. The vocalization of a baby, who can hear, ultimately merges into babbling which in time merges into speech. We regard language as a form of mental behaviour and speech as a form of social behaviour both of which accompany and condition, to a large extent, mental development. Language and its expression in speech are not the fruits of teaching but they give evidence of learning. This is our view about the development of speech in a young deaf and dumb child and the first step towards it is the preservation of his use of, and interest in, his own vocal play even though he cannot hear any sound of it.

In our experience if a deaf child ceases to use his voice its natural quality can never be recovered. If on the other hand he is encouraged constantly to use his voice to attract attention to his wants and he is led gradually to understand the kind of voice that pleases others and

wins for himself the thing he wants, his use of a pleasant voice becomes habitual. He will employ it on every occasion, often accompanied by gesture and movement to express his wants. The important thing is that his use of voice is in the first place instinctive and is an expression of his states of feeling. The hungry cry, the sleepy cry, the cry of discomfort or annoyance are all to be distinguished in the vocalization of a deaf infant. If the natural pleasant tones are encouraged so that they are repeated day after day they become fixed in the child's mind through kinæsthetic sensation and finally these pleasant sounds become automatic and serve as a natural basis for the development of speech. We have gramophone recordings which give proof of this kind of voice development both in children who are totally deaf and in those with islands of hearing. No kind of artificial stimulation through vibratory or amplifying apparatus has been given to children under three years of age. The child's natural voice at fifteen or eighteen months has been developed through use and use alone. Moreover it has been called into play by the child himself: Speech develops in a child who can hear as the result of two forms of stimulation: an urge from within which finds expression in vocal form and auditory stimulation in the form of words from without which reaches him through personal-social-relationships. Our observations and recordings confirm two facts: that a deaf child also experiences an urge towards expression and that it, too, finds outlet in vocal activity, which resembles very closely that of a child who can hear. Stimulation from without can be made part of a deaf child's experience. It, too, must reach him by way of personal-social-relationships. The trouble is that the people in his home environment rarely understand the needs of his mind. They think mainly about his bodily needs, and in satisfying them they lose sight of the true nature of the child's handicap, the gross interference to his learning naturally that which is man's most vital heritage: speech.

In infancy a deaf child's personal-social-relationships do not appear to diverge far from normal. All his obvious wants are easily satisfied in the ordinary ways because they are simple and mainly relate to his body. As an infant grows the range of his needs extends rapidly, mind as well as body determine them. The special needs of a deaf child's mind are not obvious. Gesture serves more or less satisfactorily as a means of communication so long as bodily wants and bodily development are in question. Gesture does not and cannot serve as an adequate form of stimulation for the mind. For instance, a sense of security is one of the most dominant mental needs of a child. Sense of security is brought to one with normal hearing by way of personal-social-relationships. In infancy the comforting presence of mother or nurse will suffice but later, as he grows older and achieves speech, his sense of security is strengthened, or unfortunately sometimes threatened, by all that he hears. He is told why this or that happens. Explanations and reasons are given to him

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at every turn They are the bricks in the structure of security. Few if any explanations and reasons can be given to a deaf child who has no knowledge of words. A single instance will illustrate this point. Some years ago a little deaf girl, four and a half years old, came as a new pupil to school. On the following Saturday she was allowed to go home for the week-end. When Monday morning arrived and she realized from seeing her packed suitcase that she was expected to return to school she could not be induced to get up or to allow herself to be dressed. Eventually her mother brought her to school rolled up in a blanket in a taxi. It was her form of protest. Since she has acquired speech, she and I have discussed fully this incident. I have asked her to tell me in words as nearly as she could what she felt at the time. She said, "My body seemed to be afraid and my heart was sad because I thought that Mother and Father did not love me or want me at home." That is the kind of experience that undermines a deaf child's sense of security. Such experiences must occur very often and in relation to many situations.

Earlier in this paper it was shown that a deaf child's adaptive behaviour is not retarded. Two- and three-year-old deaf children show as much intelligence, initiative and imitation in the way they play as do children who can hear. They are interested in the same kind of play and also they, like hearing three-year-olds, are more interested in their personal activities, trials and failures than in other people's. Such normal behaviour often misleads the onlooker. He sees at every turn evidence of the child's intelligence and he is apt to forget that intelligence cannot feed upon itself. Mental growth cannot occur unless there is *interaction between intelligence and suitable environment, and the most powerful dynamic in a normal child's environment is his growing mastery over speech*. This driving force is denied to the deaf child. If he remains untrained in the ways we have outlined, which lead towards speech, he acquires abnormal habits both in his thinking and in his expression of thought. These habits militate against the acquisition of speech when the child is older. In our clinics we try to help the parents of young deaf children to understand the importance of all this and we show them so far as we can in practice how to encourage the child to use his voice, watch for speech and to expect it from all in his environment.

We believe that this way of approach to speech by the pre-school deaf child influences for life his attitude towards it. This kind of preparatory training in no way diminishes the need for special education as soon as a child is old enough for it. In the majority of cases that is by the age of three. Language, speech and lipreading are the three forms of mental behaviour through which a deaf child's personality can develop most fully. Each of these three mental activities are promoted and developed in him through particular kinds of stimulation. For this reason special knowledge, skill and technique are required by those who teach him.

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Language is a growth in the mind of a deaf child but he must be taught how to apply it. The habit of talking cannot be taught to him but he must be taught how to articulate. The habit of lipreading, like the habit of listening, must be developed, but its development in a child who has no knowledge of words depends upon special technique and methods of training. In no other branch of teaching are similar technique and methods either suitable or necessary. It is for this reason that we deprecate any decision about the education of a deaf child that does not secure for him specialized help which can only be given to him by a skilful fully qualified teacher of the deaf.

THE NATURE OF DEAF MUTISM— CHILDHOOD AND ADOLESCENCE

By A. W. G. EWING* (Manchester)

IN the preceding section of this paper evidence was given by Mrs. Ewing to show that by the age of three years the mental development of the deaf and dumb child has begun to diverge profoundly from that of the child who can hear and talk. This is proved by his behaviour when analysed by the application of standardized tests and norms. Knowledge about deaf children under four years of age greatly facilitates an understanding of the results of investigations into the abilities of deaf children in later childhood and adolescence.

Not long ago it was shrewdly remarked by one of our post-graduate research workers that much investigation has been made into the abilities of deaf children over a period of more than twenty years, but that there has been little or no co-ordination. To use a military analogy there has been plenty of reliable news, but it has all been under separate heads. There has been no adequate picture of the situation as a whole. The closer study of younger deaf children has already gone far to provide a remedy. The purpose of the present paper is to show how knowledge of younger children is helping to give coherence to all that was previously known about deaf-mutism.

The average educational attainment of deaf children has been measured both in the United States and in this country. In 1928 the National Research Council published the results of a survey of American schools for the deaf. It was found that the educational attainment of deaf pupils of twelve years was comparable to that of children with normal hearing four years younger. Beyond that standard the progress of pupils in schools for the deaf tended to be very slow. At fifteen years of age the average attainment of deaf children, when judged by normal standards, had advanced only to the level of nine-year-old children. More recently pupils of English schools for the deaf have proved to be severely backward in reading and somewhat less backward in arithmetic.

Hearing Aids and Lipreading

In our own work from 1924 onwards we had concentrated especially on studying the significance in the education of deaf-mutes of small

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residual capacities to hear. In 1937 when hearing aid apparatus had been in use for a number of years permission was obtained to test the pupils in one of the largest English schools for the deaf. Measurements were made of their capacity to lipread and their capacity (if any) to hear speech with the unaided ear. Capacity to benefit from the use of an aid, with and without lipreading, was also examined. Of 116 children between the ages of nine and fifteen years, seven were excluded, because, although their ability to hear speech was sub-normal, it was good enough for them to have learned to talk naturally. Amongst the remaining 109 children, all of whom were admitted to school as deaf-mutes, 63 per cent. were reported as born deaf and 37 per cent. as having acquired deafness in infancy. Fifteen per cent. of all the children could obtain a small but significant score without help from lipreading or from a hearing aid in a test which was given in an mf voice at a distance of one metre. When using a group hearing aid designed for school use by Dr. T. S. Littler the total percentage of children who could score in the hearing for speech tests rose from 15 to 37 per cent. Measurements were made of the extent of help given by the hearing aid as a means of facilitating the understanding of speech. For individual children this varied over a wide range, but it was in every case appreciable. As a group the forty-three children who showed any capacity to hear speech were 33 per cent. more accurate in recognizing it with the aid and lipreading together than they were when relying on lipreading alone. For these children the instrument is an aid to learning although in no sense is it a substitute for lipreading. It is a form of mental stimulation which should be provided to the maximum extent possible.

The results of all the tests which we have made of the capacity of deaf patients to follow speech emphasize with stark clarity the magnitude of the task which confronts deaf-mute children in acquiring their native tongue. We find that proficient lipreaders who cannot hear the voice follow the syllables of which speech is composed with about 40 per cent. of the accuracy with which they are heard by the normal listener. Such skilled lipreaders, if familiar with the subject and with the language in which it is expressed can follow the connected speech of a clear speaker with few mistakes. Dr. Harvey Fletcher and his colleagues at Bell Telephone Laboratories have shown that sentences can be followed with 90 per cent. accuracy on a telephone system so inadequate that the syllable articulation is only 30 per cent. Understanding of the construction of meaning on so slender a foundation of perception, whether through hearing or lipreading, makes heavy demands on intelligence and mental energy. The extreme difficulty of grasping an unfamiliar word on a poor telephone is familiar to us all. But let us try to imagine having to learn a completely unknown language through an imperfect telephone system without any help from a textbook. If we go further and try to conceive

The Nature of Deaf Mutism

what it would be like to have no previous experience or comprehension of words of any kind we may approach an understanding of the barrier which before he is trained and taught isolates the young deaf-mute from communication through speech. He can be stimulated and helped to cross this barrier by those who understand his difficulties but this is surely one more proof of the indomitable and amazing vitality and power of the physical and mental equipment which is part of our racial inheritance.

Motor Control

The audiograms of deaf children show in many cases high-tone deafness, with acuity by bone conduction as much affected as by air—hearing curves of types associated with an otological diagnosis of internal ear or nerve deafness. To find whether their motor development is handicapped, possibly by labyrinthine lesions, our investigation was carried further. The tests of motor co-ordination originated by Oseretski, were given to 92 of the deaf pupils. In its final form the scale provides six tests for each of the years from four to ten, and six tests for each two years from ten to sixteen. These tests can be administered without recourse to verbal instructions. In spite of what seemed excessive difficulty in a few of the items satisfactory results were obtained with two groups of normal children who were used as controls for the deaf groups. The average motor index for thirty fourteen-year-old girls with normal hearing was 95 with a range of 84 to 103 and for twenty ten-year-old boys the average index was 98 with a range of 90 to 104. The tests were next given to thirty-six boys and girls with no capacity to hear speech even through a powerful hearing aid, whose defect was reported to have dated from birth, also to a second group of thirty-two deaf children who had some small capacity to hear speech with the help of a hearing aid. Both deaf groups showed retardation in the tests as a whole. The average motor index was 80 for the group with some capacity to hear speech and 74 for those with none. The retardation, however, was not all-round. The most significant feature of the results was that the children who could not hear speech gave very inferior performance in tests of general static co-ordinations, i.e. in those items designed to measure capacity to balance the body. Six of the thirty-six deaf children in this group failed in the simplest of these items, at a level at which normal four-year-old children succeed. Yet in the items testing manual dexterity the means for both groups of deaf children approximated to normal. Among those without capacity to hear speech eleven out of thirty-six children showed accelerated development in this respect. It seems, therefore, that in cases of deaf-mutism movements and postures which necessitate balancing the body are markedly affected. This disability is to some extent proportionate to the degree of deafness. It is not surprising to have to reach this conclusion, and it is all the more satisfactory to note that many children

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who suffer from severe or total deafness can reach standards in manual dexterity which are normal or even above average.

Practical Ability

Proceeding from the more physical aspects of deaf-mutism to its mental characteristics we gave Alexander performance tests to 150 children, all of whom had been severely or totally deaf from infancy. The Alexander tests were chosen as a very reliable means of measuring Spearman's factor "g". Dr. Alexander in his monograph states convincing grounds for believing that the results of his series of performance tests are an index of practical ability. In our investigation 121 normal elementary school children were tested as a control group. They were closely matched to the deaf children in age and social status. The results indicated two conclusions. First it was evident that amongst the deaf children there was a somewhat large proportion with markedly sub-normal practical ability. It is not yet possible to state the incidence of mental backwardness amongst deaf-mutes. It may be higher than among children with normal hearing. In areas outside London the total number of severely deaf children has apparently not been found large enough to justify the establishment of special schools for the mentally backward deaf. They are taught in separate classes but in the same school as other deaf children. Apart from this sub-group the deaf children tested by us were shown to possess as good practical ability as the control group. Indeed the proportion of children with performance quotients above 120 was larger amongst the deaf than amongst the normal children. This finding that in tests of practical ability the scores of deaf children in general are not inferior to those of normal children is consistent with those reached in previous investigations, notably that of Professor Dreyer and Dr. Collins, who have published norms founded on the administration of their series of performance tests to tests of 1,000 unselected deaf children.

At this point it is helpful to refer once more to the results of tests and observations of deaf-mutes in infancy and early childhood, because they throw so much light on the results of tests of deaf children of school age. The good practical ability and manual dexterity of the school pupils is seen to be entirely consistent with the normal standards of adaptive behaviour reached by the younger children. The finding that children who are totally deaf begin to sit up and to walk without support later than children with some capacity to hear is in agreement with the marked retardation in capacity to balance themselves observed amongst older children without capacity to hear speech. Excluding the percentage of cases in which deaf-mutism is associated with mental backwardness the evidence points to the conclusion that children with normal hearing have no superiority over the deaf in Spearman's factor "g".

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Mental Development

Important though it is, this contribution from the study of young deaf children has an aspect which is even more essential, namely to our understanding of the way in which their mental growth is affected by education. The interdependence of development in speech and in thought was analysed and described by William and Clara Stern, two of the pioneers of child psychology. Susan Isaacs has described how children with normal hearing begin to ask questions at the age of three and Gesell has found it normal for them to comprehend three out of four questions at the age of four. Professors Lewis and Valentine have observed that babies with normal hearing respond to the human voice in their own fashion with cooings and inarticulate cries as early as two or three months after birth. The foundations of normal social personal relationships are from the first intimately associated with the use of voice. How much normal mental growth is conditioned by the interchange of experiences through speech has been well described by Professor Cyril Burt in his book *The Backward Child*. He says, "In a well-to-do household, where the family is small and means are adequate, where the father is a workman with an intelligent interest in his work, where the mother is a woman with the inclination and the freedom for intellectual pursuits, the child will begin school life with the foundations of his education already well laid. As he grows older, he will pick up almost as much general knowledge at home as in the classroom, he will learn more during his leisure hours about the world and its ways than he does from any formal lesson at school. At meals, and in the evenings, and during his walks abroad, he will share (his parents') conversation, and thus imbibe from day to day a store of worldly wisdom." Speech then, is a means to an end. Children may sometimes talk for the sake of talking but usually they talk because there is something they want to talk about. Their linguistic aptitude is developed, they acquire vocabulary and command of syntax, because their ultimate ends, social, practical and concrete, cannot be achieved otherwise. It is in the attempt to elucidate deaf children's mental growth, in this wider sense, that analysis of their educational attainment is most valuable.

It is noteworthy that in the matrix test, devised by Dr J C Raven and now in use at all recruiting boards, 158 unselected deaf children tested by our collaborator Dr Gandine Stanton, proved markedly less successful than 800 unselected school children of similar social status. According to norms provided for use with normal children and obtained from Dr Raven's work in East Anglia, 75 per cent of the deaf children were below the average and nearly half were definitely sub normal. Taking the results of the Alexander performance tests into consideration, it seems unlikely that the majority of the deaf children had poor success in the matrix test because they were deficient in "g". It is more likely

that their capacity to manipulate percepts is incompletely developed because they have had sub-normal opportunities of stimulation to mental growth through linguistic experience.

In an attempt to summarize on a quantitative basis the outstanding features of the mental processes of deaf children as shown by their written and spoken expression we have analysed their comprehension of directions in Burt's reading tests and we have applied Gesell and Terman-Merrill norms to their spoken and written language. Thirty-eight unselected deaf mute boys and thirty-four girls aged twelve to fourteen years, pupils of two different schools, obtained average scores much below those of unselected normal elementary school children of a corresponding range of age. The failures of the deaf children were due especially to two causes. There was evidence of "canalization" in their vocabulary—a child who could fulfil the instruction "Fetch me a pen" might fail if it were worded "Get me a pen". More important, they had difficulty in fulfilling verbal instructions if they were complex. The Terman-Merrill norms which were applied to the deaf children's spoken and written expression distinguish between mere enumeration of items shown in a standardized picture and attempts to describe and interpret what is depicted. Capacity to enumerate is found amongst ordinary children who have not long learned to talk and ability to describe and to interpret begins at about the age of four years. The marked lateness of the age at which description and interpretation first occurred was characteristic of both the spoken and the written responses of the deaf children. But among forty-nine unselected deaf children considerable less retardation was shown by twenty-six who had had the opportunity of hearing speech even though in many cases such opportunity had been of brief total duration—a few hours weekly with the help of a hearing aid in school. That these children possess a definite advantage over those without experience of hearing speech was shown when Gesell's criterion of the use of pronouns, past tense and plural number was applied to their spoken and written language. There are good reasons for concluding that the linguistic retardation of deaf children in both these ways is that it is only when they reach a certain level of mental growth that they are ready to learn the appropriate word forms.

Burt's Scholastic tests, Catell's vocabulary test and the Northumberland group tests were given to a small group of thirteen unselected deaf pupils who had been taught individually by private tuition. They came from middle or upper class homes; all were in the first place deaf-mutes. In eleven cases the tests showed that educational attainment was raised much beyond that critical eight-year-old norm at which progress of pupils was reported to slow up or to halt. Six of these pupils have already reached high standards of educational attainment. One holds a research appointment in a Royal Ordnance Factory after taking a Science Degree

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with second class honours at Cambridge. A second is filling the place of a man (absent on war service) in a Civil Engineer's office. A third operates a comptometer in the offices of an engineering firm. A fourth is a student at an agricultural college. Two more have attended schools for normal girls with conspicuous success. Three are still being taught as deaf pupils but have already achieved a standard in reading which is equal to that of boys and girls of average intelligence of their own age. The four remaining pupils have had less opportunity than the rest but their educational attainment is markedly higher than that of normal boys and girls of nine years. In every instance lipreading was facilitated to a valuable extent by experience of hearing through amplifier apparatus. The degree of success which the progress of all these pupils implies may be attributed, we believe, most of all to opportunities of mental growth. Their records show that this growth was proportionate to opportunity of intercourse with normal adult minds. Regular hours of instruction and specific teaching in articulation, reading, writing and general school subjects had their essential place. But as the spoken and written expression of these pupils shows by its progressive development, the kind of daily talk on all manner of subjects which Burt describes, was these children's mental daily bread. Capacity to acquire language, in progressively more advanced forms, can only be developed step by step, most of all through talk in the sense of two-way traffic.

The essential criterion which must be applied to the education of deaf children, whether individually or in schools, is "How far is the intervention of the teacher making speech a bridge between these children and the normal world?" Above all "To what extent are the children learning to enjoy conversation with normal people out of school as well as in school hours?"

If we may end on a personal note may we say how glad we are to have this opportunity of discussing with otologists the education of deaf children. May we hope that you, on whose advice the future welfare of deaf children so often depends, will prescribe for them, at the earliest possible age that form of mental diet which carries the fullest complement of vitamins. There can be no pause or rest for any worker in this field until the wider opportunities, so far offered only to a few, are made available to all deaf children.

Last of all we would acknowledge the great indebtedness of our department at Manchester University to the Medical Research Council and to the Trustees of the late Lord Leverhulme, for financial support.

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that their capacity to manipulate percepts is incompletely developed because they have had sub-normal opportunities.

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THE ÆTIOLOGY OF OTOSCLEROSIS

By LEO SPIRA (London)

THE regulating influence of the parathyroid glands over the calcium metabolism of the body is a well-established fact. When their function is disturbed, either as a result of their partial or total removal, as demonstrated by Erdheim (1906) in his experimental parathyroidectomy on rats, or through surgical damage in the course of strumectomy in man (Boothby, 1931, Boothby, Haines and Pemberton, 1931, Holtz, Gissel and Rossmann, 1934, Lachmann, 1941), a disease picture develops which is variable in its extent but uniform in its course. It has been observed that fluorosis, a condition produced by the protracted ingestion of toxic amounts of fluorine, bears, in several respects, a striking resemblance to this disease picture. The suggestion has, therefore, been made (Spira, 1942 a, b, 1943 a, b) that signs and symptoms characteristic of fluorosis are produced by fluorine indirectly, namely through its interfering with the normal function of the parathyroid glands. Examination of the parathyroids of experimental animals exposed to toxic amounts of fluorine revealed, however, inconclusive results. Further investigation will be needed before deciding whether the disturbance in the concentration of calcium in blood and tissues is brought about by fluorine in a direct manner, or secondarily through an alteration in the parathyroid glands. Lachmann (1941) suggested the possibility that, in the process of hypoparathyroidism, a calcium-regulating centre in the brain is involved. Whatever the mechanism of chronic fluorine poisoning, in its ultimate effect the action of fluorine consists in its ability to precipitate calcium salts stored in the body as a material indispensable for sustaining the vitality of most of the organic functions, and to substitute sodium or potassium for the calcium which has been removed. This results in a lowering of the level of the serum calcium.

The pathological changes produced by hypocalcæmia on the body are manifold. Outstanding amongst them are those affecting the skeleton. In his experimental parathyroidectomy on rats Erdheim (1906) demonstrated that tetany which followed it (*Tetania parathyreopriva*) was in some cases accompanied by *osteomalacia* and *rickets*. *Osteosclerosis*, *osteoporosis*, *exostoses* and *fragility* of the bones, on the other hand are well-recognized signs of chronic fluorine poisoning. Its other characteristic signs are various dystrophies of organs known to be likewise regulated by the parathyroid glands, namely the skin and its appendages, the teeth, nails and hair. The appearances in "mottled teeth", as demonstrated in particular by the opaque, paper-white patches, varying in size and shape, and horizontal bands of varying width (Fig 1), were shown

(Spira, 1942 b ; 1943 a, b) to bear a close resemblance to the appearances in "mottled nails", particularly as seen in that variety of the nail dystrophy which is known as leukonychia, and which exhibits dull, opaque, chalky-white specks, patches and transverse bands (Fig. 2). Both, mottled teeth and mottled nails, are easily detectable diagnostic signs of fluorosis.

In the course of investigating the relationship of fluorosis with hypoparathyroidism I was impressed by two facts : (1) that, in collaboration with Erdheim (1906), two well-known Viennese otologists, Neumann and Ruttin, observed that some of the parathyroidectomized rats were affected by a disturbance of the equilibrium, labyrinthine in origin ; (2) that the number of people in this country suffering from otosclerosis appeared to run parallel with the high percentage of those suffering from fluorosis in a varied degree. The fact that deafness due to otosclerosis seems to be much more common in this country than it is elsewhere was also commented upon by many who had the opportunity to compare. The question, therefore, arose whether any connection existed between otosclerosis and chronic fluorine poisoning.

The clinical picture of otosclerosis is well known, but its aetiology remained obscure until it was suggested that it may be due to endocrine disturbances. It was, however, only when Frey and Orzechowski (1917) drew attention to an association of otosclerosis with latent tetany that parathyroid insufficiency became the subject of an ever-increasing interest in the search for the causation of the disease. In fact, by some investigators the level of serum-calcium has been found diminished in as many as 84 per cent. of patients suffering from otosclerosis. Since it has been suggested that in fluorosis, too, signs and symptoms are produced through the medium of the parathyroid glands, it became a matter of interest to investigate the extent to which the two conditions, otosclerosis and fluorosis, stand on common ground. In any study of the problem of otosclerosis the résumé of the literature on the subject, as compiled by the American Otological Society (1929), is invaluable, since it draws a lucid picture of the condition in all its aspects, as given in the complete collection of the available literature, right from the time when Valsalva first mentioned ankylosis of the stapes in 1735, down to the present day. It is this résumé from which the syndrome of otosclerosis is here drawn, as it refers to hypoparathyroidism, to serve as a counterpart to the description of the clinical picture of fluorosis, as given elsewhere (Spira, 1942, 1943).

Anatomically otosclerosis is characterized by patches of osteosclerotic and osteoporotic changes. Absorption of the normal bone is followed by proliferation and deposition of new-formed spongy bone in its place. Calcareous deposits, white in colour and sometimes tinged with brown, give the affected part a chalky-white or milk-white appearance (Figs. 3



FIG 1

Opaque paper white patches in mottled teeth



FIG 2

Leukonychia in mottled nails

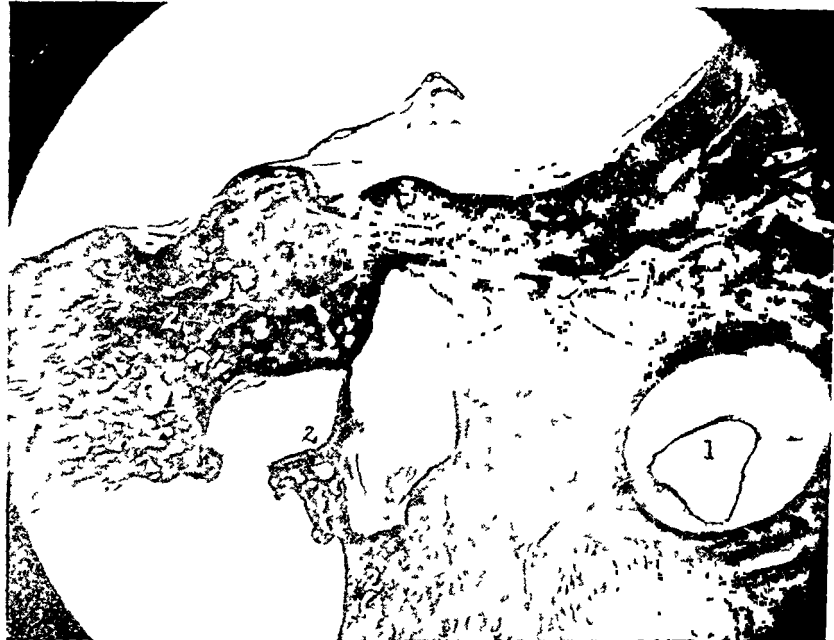


FIG 3

Otosclerosis Region of round window

- (1) Posterior canal surrounded by normal capsule (2) Focus tending to closure of round window (3) Dystrophic bone protruding into the scala tympani



FIG 4

Otosclerosis Focus in relation to cochlea

- (1) Cochlea (2) Focus (3) Tensor tympani muscle (4) Vestibule (5) Tympanum (6) Capsule

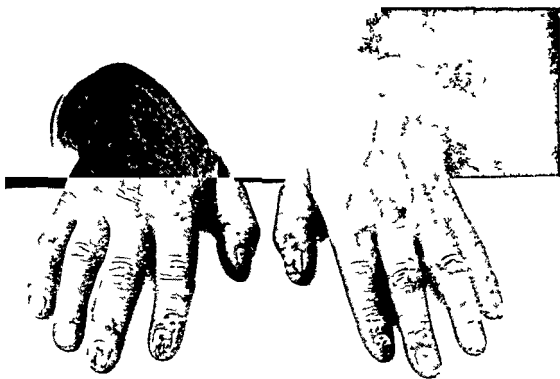


FIG 5
Advanced nail dystrophies in a case of otosclerosis

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and 4). These patches of osteosclerosis and osteoporosis may be found in any part of the petrous bone. To produce, however, the gradually progressive deafness characteristic of otosclerosis, they must develop in the bony labyrinthine capsule. It is, in particular, the anterior margin of the oval window which represents a site of predilection for the appearance of otosclerotic foci of diseased porous bone. When the base of the stapes and the annular ligament are involved in the pathological process and transformed into a white calcareous mass consisting of calcium deposits, stapes ankylosis results. As seen from the attached photographs, the sharp contrast of the milk-white colour of patches of an otosclerotic focus against the surrounding normal bone-tissue corresponds in a striking manner to the chalky-white or paper-white colour of patches of mottled nails and mottled teeth respectively, as caused by fluorine.

Otosclerotic foci are often accompanied by exostoses and by fragility of the bones. Thus the list is complete of the pathological conditions common to both otosclerosis and the protracted action of toxic amounts of fluorine, so far as the skeleton is concerned. The probability of the identity of the lesions met with in both cases is further borne out by the observation of several investigators to the effect that otosclerosis is often co-existent with osteomalacia and rickets, conditions which were mentioned also to have been produced by parathyroidectomy in experimental rats by Erdheim (1906).

In describing the symptomatology of fluorosis it was shown that the peripheral nervous system is affected. The neurological aspect of the disease picture is characterized by increased irritability of the neuromuscular system, in a manner identical with that seen in tetany. It is, amongst others, this identity of the neurological aspect of fluorosis with that of tetany which adds further support to the theory that fluorine acts on the body through the parathyroid glands. Thus the hypothesis of Frey and Orzechowski (1917, 1920) who thought that the association of latent tetany with otosclerosis points to parathyroid insufficiency as an important factor in the causation of otosclerosis is further strengthened. Moreover, there is ample evidence to show that in otosclerosis the trunk of the auditory nerve, its cochlear branch, ganglia and sensory nerve terminations undergo a marked process of degeneration and atrophy. In some cases even the co-existence of otosclerosis with an auditory nerve tumour has been observed. Neuritis and degeneration of the auditory nerve lead to degeneration and atrophy of the stapedius and tensor tympani muscles, and to their transformation into strands of connective tissue fibres. Some investigators found an association of auditory neuritis with neuritis of the peripheral nervous system in otosclerosis. In both tetany and chronic fluorine poisoning hyper-irritability of the nervous and muscular systems represents a characteristic of primary importance; in fact, paræsthesiae are regarded as a symptom

pathognomonic of both these conditions. It is suggested that a similarly increased irritability of the cochlear nerve and the neuritis of the sensory otitic plexus manifest themselves subjectively in otosclerosis as tinnitus. Tinnitus should thus be regarded as an equivalent of *paræsthesiæ*; both these symptoms being the result of the hyperirritable condition caused by the reduction of the calcium content in blood and tissues through the lowered action of the parathyroid glands. Vertigo of labyrinthine origin, observed in experimental parathyroidectomy, occurs also in tetany and otosclerosis, and has been described as one of the outstanding symptoms of chronic fluorine poisoning; it should likewise be interpreted as the result of increased irritability of the vestibular nerve.

Otosclerosis has for many years been considered by several writers to be not a disease entity, but a manifestation of a systemic condition. Some described it as due to a metabolic disturbance, since gout and various forms of rheumatism were often found to be co-existent, and the amount of uric acid in the blood increased. Others attributed it to a chronic toxæmia of gastro-intestinal origin. The co-existence of low blood pressure has been emphasized by some, and that of habitual constipation by others; and glandular deficiency as the cause of an abnormally pigmented skin, of enamel defects in the teeth, and of dystrophies of the nails and hair were found to accompany otosclerosis. Fig. 5 shows advanced nail dystrophies in a case of otosclerosis.

The knowledge of the symptomatology of fluorosis is of but recent origin, and cannot, for this reason, claim to be complete. A comparison, however, even at this early stage, of fluorosis with otosclerosis, both from the point of view of their external appearances and of their systemic disturbances here summarized, reveals that there is more than a mere coincidence in the similarity of the two conditions. Since each one of the described signs and symptoms has been observed to occur in both of them, it seems justifiable to assume that otosclerosis may be intimately bound up with fluorosis, in the sense that otosclerosis forms an integral part of the symptomatology of fluorosis. Otosclerosis would thus appear to be caused by the protracted ingestion of toxic amounts of fluorine.

This altered conception of the pathology of otosclerosis makes a full explanation of its clinical course possible. It is not heredity, in its strict meaning of the word, which plays an essential part in the causation of otosclerosis, as assumed for very many years, but an inherited predisposition to its acquisition, should an opportunity of protracted exposure to toxic amounts of fluorine arise, which is at the root of its ætiology. The action of fluorine being of a cumulative nature, it would take some time, variable in length, before an otosclerotic focus develops at the site of predilection in front of the oval window. Although it has been denied by some, the majority of observers are agreed that females are more frequently affected by otosclerosis than males. In many cases the onset

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of the subjective symptoms, deafness and tinnitus, is referred to pregnancy,

pregnancy As the pregnancy terminates, either by normal delivery at full term, or through induced abortion, the subjective symptoms of otosclerosis almost invariably show an improvement, which may persist through the entire period between two pregnancies The process deteriorates, however, again with the onset of the next pregnancy

Even without exposure to the action of toxic amounts of fluorine, the mother keeps during pregnancy only a reduced amount of calcium for her own needs, since she shares it with the foetus With a diet sufficiently rich in calcium, this increased demand can be easily satisfied, and not only does in such a case the mother remain free from symptoms of otosclerosis but the foetus, too, being adequately supplied, is not doomed to having a foundation laid for otosclerosis in intra-uterine life The danger of developing otosclerosis in mother and child arises only when the supply of calcium is not adequate before and during pregnancy Because of its ability to precipitate calcium salts stored in the body, there can be no doubt that protracted ingestion of toxic amounts of fluorine during pregnancy depletes the amount of calcium, already inadequate because it has to provide for mother as well as for foetus, to a still lower level The risk of not only developing otosclerosis in the mother, or aggravating the subjective symptoms if the disease was present before the onset of pregnancy, but also of preparing the ground for it in the foetus is thus considerably increased Guggenheim (1935) described histological abnormalities in the tissue representing the future bony capsule in a six weeks old embryo of an otosclerotic mother He also found a small focus of osseous dystrophy, histologically strongly resembling an otosclerotic focus, in the labyrinthine capsule in the region just below the round window, in a foetus seven months old The new born child can still escape the danger of developing more widespread and more advanced labyrinthine lesions in the future, if the source of fluorine intake is cut off in time, so as to prevent the level of serum calcium from being kept constantly reduced With the termination of pregnancy the mother, too, not having to part with any of her own calcium content any more, finds the subjective symptoms of otosclerosis considerably improved unless lactation exposes her to a renewed risk of continued deterioration

The conclusions here arrived at are the result of considerations concerning the action of fluorine upon the skeleton which is known to be regulated by the parathyroid glands It should, however, be noted that the isolated study of the changes produced in bone, in their relation to the action of fluorine, without at the same time studying the changes produced in the other tissues regulated by the parathyroid glands, would be misleading It is fully realized that, in the absence of corroborative

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evidence based on expert methods of otological examination capable of giving further support to the statements made, the evidence here put forward cannot be deemed conclusive. It is, therefore, of considerable interest to note the result of certain investigations carried out in the past on the problem of otosclerosis by animal experiment. Simeoni (1929) observed a disturbance in the labyrinthine capsule of experimental dogs and rabbits on whom thyro-parathyroidectomy and hemiparathyroidectomy had been performed. Borghesan (1930) found in parathyroidectomized rabbits, in addition to tetany, congestive hyperæmia in the membranous labyrinth, and also lesions, confirmed histologically to resemble human otosclerosis, in the bony labyrinth. Moreover, Lewy (1928, 1934) administered calcium fluoride to young white mice, and noted, on microscopical examination, signs of immaturity present in the labyrinthine capsule in some of the animals. No such lesions as followed parathyroidectomy were observed by Torrini (1934) after the removal of the gonads, male as well as female, in experimental guinea pigs. All these experiments, carried out since the advent of the parathyroid theory regarding the ætiology of otosclerosis, reveal findings which are in perfect harmony with the observations here described.

The complete failure in the treatment of otosclerosis in the past was due to the fact that no therapeutic measure could reasonably be expected to bring about a *restitutio ad integrum* of the labyrinthine capsule which was damaged by an otosclerotic focus. Just as the chalky-white or paper-white patches in mottled teeth and mottled nails, so also the milk-white otosclerotic foci in the labyrinthine capsule are permanent. Once established, none of these dystrophies can, in the present state of our knowledge, by any method of treatment ever be repaired. Consequently the deafness, having been caused by an otosclerotic focus in front of the oval window, will remain unchanged. It is, however, justifiable to expect that its further deterioration can be arrested by treatment directed against fluorosis. Furthermore, since this treatment proved in the past to relieve the frequency and intensity of the attacks of paræsthesiæ which occur in the hands and fingers, when caused in fluorosis by the hyperirritability of the sensory branches of the median and ulnar nerves; and since the attacks of giddiness believed in fluorosis to be due to increased irritability of the vestibular nerve were shown to be alleviated in the same manner both in frequency and intensity, it is reasonable to assume that the distressing tinnitus, which is here suggested to be an equivalent of paræsthesiæ and to be brought about by the hyperirritability of the cochlear nerve, can likewise be diminished by the same method of treatment.

The only hope of defeating the disease lies in its prevention. Prevention of otosclerosis is intimately bound up with that of chronic fluorine poisoning. Spira (1928-1943) has shown on several occasions

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that fluorosis is a disease endemic in this country, and that it is produced by the ingestion of toxic amounts of fluorine contained in the drinking water and in food prepared in aluminium cooking utensils. In collaboration with Grimbleby he suggested (1943) how excessive amounts of fluorine in drinking water can be considerably reduced. He also reported (1943 c) that the fluorine present in the drinking water is frequently derived, in this country, from the filter powder used in the process of its chemical purification, and that, like arsenic, it is often found as an impurity in minerals and metals entering into the problem of water supply.

Summary

The appearances of otosclerotic foci are closely similar to the appearances of mottled teeth and mottled nails, lesions known to be produced by the protracted action of fluorine. In addition, several signs and symptoms accompanying otosclerosis are identical with those constituting the disease picture of chronic fluorine poisoning. It is suggested that otosclerosis is a manifestation of fluorosis and that it can therefore, be prevented.

I wish to thank the Editor of the *Journal of Hygiene Cambridge* for his permission to republish Figs 2 and 5 from my article *Mottled Nails*. An early sign of fluorosis (1943 xliii 69) and Dr Louis K Guggenheim for permitting me to reproduce Figs 3 and 4 from his monograph *Otosclerosis*. St Louis Missouri 1935

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SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

Friday, February 5th, 1943

President—F. C. ORMEROD, F.R.C.S.

Discussion on Deaf Mutism

The opening papers are published in this issue of the *Journal of Laryngology and Otology*, Vol. LVIII, pp. 137-148.

PHILIP FRANKLIN

It would seem to be more or less assumed that a child born deaf or one that acquired deafness in early life must inevitably be deprived of the power of developing speech. This fallacious assumption stimulated the creation of the manual or sign language and subsequently lip-reading for the deaf and dumb. On the contrary, deaf mutes can be taught to speak at two to three years and specialized speech instruction can in fact begin as early as twenty months. These children, thought to be incapable of speech, proved to possess a power of rapid speech development with a special type of speech instruction.

In 1931 this was instituted when he opened the Deaf Mutes Speech Clinic for Pre-school Deaf Children. Stimulated by the results of three years' experience, he published a "Plea for Early Diagnosis", *Lancet*, 1935. Early diagnosis is important so that the advantages of early speech training are not lost. We have listened to the valuable contribution of Mrs. Ewing, with regard to the early speech training at her Deaf Clinic. Unfortunately few organized centres of this type are available. I would suggest that the Otological Section might consider the importance of this problem fundamentally to stimulate the formation of more Speech Training Centres for the pre-school deaf child. A beginning could be made by co-opting such an effort to the existing speech clinics now in being in many hospitals throughout the country.

Until recent years education of the deaf child did not begin until he reached seven years of age. Although this has been reduced to five years, it is not actually in force, but left as a voluntary procedure. Propaganda therefore is necessary for both the medical and the lay public to stress the early recognition and suspicion of deaf mutism, giving data regarding the advantages and possibilities of early speech training.

At his clinic children were grouped :

- (a) Those with total loss of hearing.
- (b) Those with residual hearing.

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The former, being unable to appreciate sound by the natural auditory path, were stimulated to appreciate sound vibrations by the logical substitute path, i.e. the sense of touch, by applying finger tips to a vibrating magnetic plate, connected to a microphone. The voice at the microphone constituted the sound stimulus. The instrument, the Phonotactor, may be described as electro vibratory. The use of the substitute path is logical in that by analogy the sense of touch and the sense of hearing are both adapted for receiving and interpreting vibratory stimuli. The use of the sense of touch is not of recent origin. For centuries, deaf mute children were commonly taught to feel and appreciate laryngeal vibrations by applying their finger tips to the larynx of the teacher. The majority of the congenitally deaf possess some hearing in one or both ears. The acquired type, especially those deafened by meningitis in infancy, are totally deaf. He considers every case of meningitis in infancy to be potentially a total deaf until otherwise disproved. The detection of hearing, however slight, is of importance. It permits the use of the natural auditory path, facilitating the eventual appreciation of sound and subsequent speech development. Another instrument in use at his clinic is especially adapted for this group. The instrument is electro acoustic and described as the "Audio amplifier". This instrument is calibrated and allowing for degrees of amplification up to 125 decibels. By means of calibration, one is able to determine, not only the amount of amplification necessary to create recognition of sound, but also the amount required for sound interpretation. This would be the stage at which the child could discriminate between different types of sounds. This, of course, is of the greatest value from the standpoint of speech education.

With the co operation of the late Mrs Tookey Kernidge, twelve educational gramophone records were made. These followed a sequence of sounds in the order in which they are recognized by the normally hearing child. They started with nursery noises, street noises, country noises, first words, vowels, consonants, folk-lore embodying simple rhythmic music, nursery rhymes, etc. Among the mentally defectives one finds a further problem for the otologist. In Mr Franklin's experience, he noticed a number of children, apparently defective only in that they were hard of hearing, who were undergoing education in Mental Defective Education centres. These children had sufficient hearing to enable them to attend at a normal school, if equipped with a suitable hearing aid. The harmful environment, both educationally and mentally, could thus be avoided. He spoke of a case referred to him from a Child Guidance Clinic of a child who was attending a Mental Deficient School. This child, a girl aged seven, had 40 per cent loss of hearing in either ear. He was able to procure a hearing aid, and with the co operation of the respective M.O.H., replaced this child in a normal school. He suggested the possibility of many such cases. A fund for procuring electric aids for such children would be helpful. He further suggested the advisability of an inspection of children in the institutions by otologists.

At his clinic the children were under the observation of a clinic psychologist, who recorded, by means of a Buehler Chart, their variations from the normal for sense reception, social reactions, learning, manipulation and mental production. The chart referred to is similar to the Gesell chart, referred to by

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Mrs. Ewing. The average deaf mute attains a normal standard except for sense reception and learning. This is the natural result of inability to hear and inability to learn. Investigations proved that there is no actual mental retardation at this early age. Their intelligence quotient rises above the normal after a period of amplified sound stimulation by either the natural or the substitute path.

A percentage of congenitally and acquired deaf children retain sufficient hearing function to be grouped together as "hard of hearing": For them at five years of age, an electrical aid with limited amplification within their particular range of hearing, is practical.

By means of a series of lantern views Mr. Franklin illustrated the instruments employed at his clinic. He showed a child apparently mentally deficient, with a particularly facial expression of dullness. This was followed by another view of the child showing the remarkable facial development into an alert and bright expression, after undergoing two months' speech training.

Experience of sound stimuli by either the natural or substitute paths tends to stimulate mental interest and alertness.

The usual hearing tests are not of practical value. He uses the rotatory labyrinth test as a guide in determining the presence or absence of hearing. A nystagmus response to rotation indicates hearing however slight. He showed a lantern view of twins, one normal and one deaf. Both were simultaneously rotated. The deaf child showed no nystagmus reaction and on leaving the labyrinth chair was able to walk normally a short distance to pick up a doll lying before him on the ground. The normal child gave a nystagmus response and on leaving the chair walked with a staggering gait. He showed a normally hearing and healthy married couple who produced three deaf children. By contrast he showed another couple who had met at a deaf institution, subsequently married and produced two normal children. In his experience 80 per cent. of 400 cases under his observation were unaware of any familial history. Eugenic sterilization would in consequence have little effect on the incidence of deaf mutism. Further illustrations showed the methods used by the voice therapists, also illustrations of the finger-tip application of the deaf child when using the Phonotactor. Another illustration showed a child of twenty months under stimulation.

In conclusion his experience with the pre-school deaf child has demonstrated that much can be accomplished by early recognition and early education. When these children attain school age further speech development is facilitated. This early attendance and early discipline in class training, creates a better social reaction as well as an active and receptive brain. He is, in consequence, better equipped to benefit from school age education.

Mr. Franklin said that Mrs. Ewing had misunderstood him. He had not suggested an audiometric test for children of pre-school age as it is not practical. He had, however, emphasized labyrinth response to rotation and the presence or absence of nystagmus. One must in the main rely on the palpebral reflex and other facial reactions. The mother's suspicions of profound deafness are usually justified. If observant, she may suspect deafness as early as six months.

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DOUGLAS GUTHRIE

proposed to consider the subject under three headings

- 1 The Education of the Deaf Child
- 2 The Employment of the Deaf Adult
- 3 The Use of Sign language by the Deaf

1 Cases of almost total deafness were often brought to the otologist in childhood. It was extremely difficult to decide whether the child was deaf or mentally deficient, and for that reason many cases of deafness were missed, or rather, were allowed to go on until the child reached school age. By that time he had lost the benefit which might have been obtained from early education, as it was now realized that the education of a deaf child ought to begin as early as three years. Dr Guthrie had been surprised to learn that at one large school for the deaf the average age of entrance was seven years. The headmaster stated that the reason was that either the parents or the doctor failed to recognize the condition. It was a matter of supreme importance that these small children should be carefully examined so far as hearing was concerned, so that, if a severe degree of deafness was discovered, they might be brought under educational supervision at an early age, and even sooner than three years, if possible. To attain this end, it was the doctor who should first be educated. The average oto laryngologist knew little of the physiology of speech and voice, and was therefore not in the best position to deal with the deaf child. He should not confine his attention to diseases and operations, but should know something of phonetics, of the physics of sound, and of the methods of education at present in use. Many oto laryngologists had never visited a school for the deaf and did not know how the teaching was conducted.

2 The medical man ought also to possess some information regarding the possibilities of employment for the deaf. Provided there was no handicap other than that of being born deaf, children educated in special schools for the deaf were all employable and, at the present time, according to information received from the National Institute for the Deaf, it would be true to say that 100 per cent were actually employed. Naturally the employment varied with the economic condition of the country, and in times of industrial depression employers showed a tendency to fill the available posts with those who could hear, but after an employer had had experience of deaf employees he was ready and willing to accept more, as they proved to be most conscientious workers. This was largely because occupational training was given in schools for the deaf and was continued until the age of sixteen, and in two of the trade schools until eighteen years. Some years ago the question of employment was raised in a report by Dr Eicholz, who stated that the position of the deaf mute in regard to employment was that he was able to earn a living at any trade followed by ordinary persons, with one limitation only, namely, that he was debarred from entering a trade in which hearing was essential. Still the majority of trades were open to the deaf if only they could succeed in gaining admission. Notwithstanding this fact the employments for the deaf appeared to narrow down to a few trades, including tailoring, boot repairing, cabinet making, and laundry work. The narrowing of the field said Dr Eicholz was not connected with any limitation of capacity on the part of the deaf, but rather with the restriction

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of vocational training, and with lack of enterprise on the part of the authorities concerned to seek out new avenues in which a livelihood could be gained. Dr. Guthrie had been in touch with the Secretary of the National Benevolent Society for the Deaf, who was responsible for placing in employment large numbers of deaf persons. He replied that with very few exceptions the deaf and dumb could earn their own living, and at the present time there were no unemployed on the list, except the aged or infirm. In normal times, however, employers feared the extra trouble involved in training a deaf employee and the additional risk under the Workmen's Compensation Act. Both these fears were groundless, and employers of the deaf were generally willing to take others as vacancies occurred. Frequently the deaf were exploited, a point which should be borne in mind. When the Eicholz Report was written, the main employments for men were tailoring, boot making, farm work, and gardening; and for women, domestic and laundry service and dressmaking. Since then, Parke and Crowden had established that this limitation of employment was not at all essential, and that there were no fewer than 340 different occupations available for the deaf. Although the deaf person could not be a telephone operator or a piano tuner, there were numerous other occupations, and the medical man should be familiar with the possibilities so as to be in a position to advise his patient, or, more important still, to influence employers who were faced with the problem of employing deaf persons, by saying a word in their favour.

3. A third problem to be faced by the medical profession was the use of signs by the deaf. Aids to hearing were of the first importance and much attention had been given to their selection. But for those who were totally or almost totally deaf, or who had not profited from oral education, was there not some place for sign language? The deaf child who retains some small degree of hearing and who has been specially educated, continues to use speech after leaving school, especially if encouraged to do so at home or at work. Nevertheless, as things stand at present, the adult deaf tend to congregate in missions, where the majority preferred silent conversation. So long as the conversation was carried on in the English idiom, no great harm was done by such "finger spelling". It was the use of conventional signs that kept the deaf from rising into the higher realms of thought and culture. The Secretary of the Deaf Employment Society (already mentioned) had told Dr. Guthrie that in general oral speech was not used among the adult deaf except in a few cases with intelligent friends. They had, in fact, all "lapsed", although he objected to the use of this word as it conveyed a derogatory meaning. The current opinion among the adult deaf was that the manual method was not sufficiently used during school days. It was strongly discouraged by all teachers of the deaf, and rightly so, but was there not some place for it when adult life was reached, especially for the totally deaf? In his interesting work on "Human Speech", Sir Richard Paget had suggested that all speech originated through signs. The signs had been transferred from the hands to the mouth, and what we called speech was really mouth gesture to which sound had been added. In a letter to *Nature* a few months ago Sir Richard had advocated the use of signs as an international language. He stated that more could be expressed by the hands and by signs than by the speech apparatus as commonly used, and he

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would like to see all children in all countries taught sign language as a form of play. Many authorities would not agree with this view, and few would permit the teaching of sign language to deaf children, however useful it might be to children who had already mastered the mother tongue. Nevertheless, finger spelling was quite another matter and must be carefully distinguished from sign language. There might well be a place for finger spelling in the teaching of the deaf, when the deafness was profound or when the oral method had failed, as sometimes happens. Finger spelling was in fact the mother tongue and it opened a means of communication with the outer world to children who must otherwise live in almost complete isolation. The proportion who must be taught would not be very great, but they should be carefully selected and not simply be allowed to drift on as the dullards in oral classes.

Mrs EWING, in replying to the discussion, said that she warmly supported the idea of founding clinics for the deaf. These need not be attached to a university, like the one at Manchester, which was both a clinic and a research centre, but clinics for the deaf should be attached to hospitals throughout the country. She agreed with Mr Franklin entirely as to the need for stimulating young deaf children. She only disagreed concerning children up to the age of three. She could not rely on her own audiometric tests for children under the age of four, and as a teacher she did not like the idea of using heavy vibratory apparatus in the case of very small children. The desired results could be obtained in another way on natural nursery lines.

Again, was it the case that just hearing sounds stimulated speech? One could listen to the chirping of birds, the flying of aeroplanes, one could have a range of sounds from the shrillest whistle to the deep throb of the bomber, but without words these would not stimulate speech. It was the content of words, not merely the ability to hear sounds, which must be brought into the child's experience. In the early stages the child was taught words very largely by watching the expression on the teacher's face. Later, he watched the lips for particular words and phrases which developed an understanding of speech.

With children over the age of five it was possible to make reliable audiometric tests. Any remnant of hearing a child has must be educated and trained. Hearing and lipreading must be blended together. The teacher must know exactly the proportion of each. The child was never going to be able to hear all the sounds audible to the normal ear, he must be taught to rely on those parts of words which he could hear and see to form an intelligible meaning.

She wished to correct Mr Franklin on one point. The Board of Education had lowered the age at which deaf children might enter school to five years, not seven, and it had been made permissible for such children to enter school at the age of three or earlier.

Dr A W G EWING, also in reply, said that first of all he desired to acknowledge the debt which was owing to those whose work involved a close study of the subject, and especially to Dr Guthrie for his contributions to the *physiology of speech*.

There was no official post elementary education for the deaf in this country as yet, and that was why it had been possible in investigating the matter to take only a comparatively small number of cases of deaf mutes, principally of children whose parents were better off financially and could afford to give

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them a better education. All the evidence so far seemed to show that the child deaf mute was not in the majority of cases a mentally backward child. The limits of educational attainment were not imposed by deficiency in natural intelligence, but by lack of opportunity. Both in this country and in America children born deaf who had had greater opportunities of education had passed beyond the educational level which he mentioned at the beginning of his paper. Dr. Eicholz's report showed the improvement of vocational training and there were three centres in this country where full-time vocational training was given. It was found by Dr. Eicholz in his survey that it was rare for a deaf mute who had had full-time vocational training to be out of employment, and that survey was made in the depth of the industrial depression of 1930. Again, it was a question of opportunity.

As for the sign language, here Dr. Guthrie did differentiate, he was glad to know, between the sign language and finger spelling, but in practice those who relied on finger spelling to any appreciable extent liked to shorten the effort as far as possible and resorted to the conventional sign system. When he first began to work amongst the deaf he taught for three years in schools of deaf. An old-fashioned teacher who had little belief in teaching speech to the deaf had a child up "on the carpet" for having spent some money at a shop on Sunday. This master said to the child: "Yesterday—money—spend—why?" It would be seen that the signs were of a different order from the words as they were used in English. Often one found a single sign used where several different words indicating important shades of meaning would be employed in any civilized language. A distinction should be made between the adult who had normal language capacity and was using signs to the deaf mute and the deaf mute himself who had no other language at all. The latter had only one sign, one gesture, one symbol to express a number of different ideas. Take the sign for "good". It might mean "Good-morning" or "Are you well?" or "That is a satisfactory performance" and all sorts of different things.

A study of the wolf child referred to by Gesell was very helpful. It took this child some years after being rescued to understand any normal language, and Gesell concluded that that was because she had acquired a different way of thinking. So it was with the deaf mute. He acquired a different way of thinking, and that came out again and again in children who had learned the sign language first and English afterwards. For a long time their English tended to be a translation of sign language and showed its characteristic deficiencies.

Historically it was unfortunate that two of the most able teachers of the deaf in the earlier days (the eighteenth century) who lived in Edinburgh, kept their knowledge of more advanced methods of teaching the deaf to themselves, and a deputation from the United States who came over here to study methods of teaching the deaf went away unsatisfied. They went to France where they found the Abbé de l'Epée who was teaching a sign manual method.

As regards the use of speech, an investigation in the Potteries carried out by one of their graduates showed that leavers from deaf schools did not lose the speech they had acquired and that often their language capacity seemed to increase.

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Mrs. EWING : That was up to twenty-five years of age.

Dr. EWING went on to say that with regard to the whole question of the education of the deaf the economic factor had to be considered. They had to be taught in special schools and that meant that where the schools were residential an artificial community was created. If the communication between the children in the schools lasted over a longer period than their communication with people outside a form of mental inbreeding took place.

The problem seemed to be indicated on these lines : physically the effects of deaf-mutism were not very grave, but they were most serious in the deprivation of opportunity. It was very important to incorporate the deaf as far as possible in normal life and activities and there the otologist could be of great assistance in bridging the gap.

LETTER TO THE EDITOR

TO THE EDITOR,

The Journal of Laryngology and Otology.

MALIGNANT MELANOMA OF PALATE AND FAUCES

DEAR SIR,—With regard to the record of the case of a woman of 43 that you published for me under the above title in the January issue, my attention has been called to the fact that there was no specific mention of the pathologist's report. Sections were examined by two pathologists who both agreed as to the malignant nature of the tumour. Furthermore, I have just heard that a week ago the patient unfortunately died with secondary melanotic deposits in the liver but no sign of local recurrence.

WALTER HOWARTH.



The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

June 1943

NASAL ALLERGY (EXCLUDING HAY FEVER)

By GEORGE BRAY (London)

THE allergic nose is presented first to the rhinologist and forms at least a third of his practice. When finally it is exhibited to the allergist it portrays a composite picture of allergic œdema, if any membrane is left superadded infection and scars of previous surgery. The best prognosis can be achieved only when the allergist sees the case in its early stages, and the truest perspective can be attained only by the stereoscopic fusion of the pictures as seen by the pricker and the chiseller.

"A symptom is known by the company it keeps" (Coca), and allergy should be suspected always in cases experiencing nasal itching, sneezing, running, blockage, anosmia and polyposis, especially if there is a family history of asthma, hay fever, vasomotor rhinitis, eczema, urticaria or migraine, or other similar manifestations in the individual. The nasal symptoms are an exaggeration of normal physiological functions. First the warming and moistening of inspired air. Normally the turbinates on one side are filling whilst those on the other side are throwing off secretion, a cycle recurring each $2\frac{1}{2}$ hours, also the contents of the turbinates are largely controlled by gravity, so the nose more easily obstructs on the dependent side. Secondly, the filtering of the air. In the allergic nose the warming and moistening function is exaggerated on the least cold stimulus and in filtering the air a localized urticaria appears where the particles to which the patient is sensitive lodge; this is most marked in the middle meatus because this area is physiologically the inspiratory zone and so subject to the greatest irritation, and histologically the least equipped to deal with œdema as it has only the slightest supporting stroma. With transitory irritants and reactions the allergic changes are reversible, hence pure hay fever sufferers rarely

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develop polyps or infection, but when the irritant is permanent from perennial causes polyps and infection become more frequent.

Nowadays most mucous polyps are considered allergic in origin. They are usually located on the middle turbinal and in the middle meatus, the main inspiratory areas. They result from continual irritation of allergens in an area where the stroma is particularly loose and the mucous membrane can easily prolapse. If the irritants are determined and removed early and the membrane desensitized to further irritation small polyps can regress and disappear and further formations be hindered. Without allergic management surgical removal of polyps needs frequent repetition.

In a person with an allergic predisposition the first nasal discomfort usually follows an acute upper respiratory infection which lowers the patient's resistance whilst the inflamed membrane allows a more rapid absorption of inhaled particles; so the original sensitizing substance is usually some common factor in the environment at the time of the illness, either at home or at work, and not related to the type of the invading bacteria. Others date the onset to a nasal operation. In further cases a more prolonged lowering of resistance is necessary, and the first symptoms appear after pregnancy; at the menopause; following fatigue, strenuous exertion or prolonged worries or emotions; in short, during states where the protective adrenaline secretion of the body is diminished or nearly exhausted.

Allergic nasal symptoms are usually worse in the early morning on waking or on getting out of bed because first, of prolonged contact with some irritant in the bedding or bedroom; secondly, the added physiological irritation on changing from warm air to cold, or when the feet touch cold objects (physical allergy); and thirdly, that possibly during rest the secretion of adrenaline is at its minimum. The effect of cold on the majority of allergic noses is interesting. First, it may represent, merely the exaggeration of a normal physiological function; secondly the patients may be less able to deal with cold as the majority have a lowered basal metabolism; and thirdly, the cold may act as a physical allergen, a cold draught over an exposed foot causing nasal symptoms through histamine production. Some years ago I reported the case of a boy sensitive to cold. When a hand was placed in cold water it swelled like a boxing glove, the lymphatics to the axilla became very swollen and hard, and later the boy had profuse rhinorrhœa, an attack of asthma and even wet the bed.

Besides the nasal symptoms mentioned a chronic cough may develop from the muroid post-nasal drip; or the resultant mouth breathing of cold, unfiltered air convey irritant particles to the pharynx and later to the lungs causing asthma; or headaches or pressure symptoms may follow blockage of the sinuses, or even a real migraine attack may

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supervene, and usually increasing deafness from blockage of the Eustachian tubes

The usual specific sensitizing substances include

- I INHALANTS Feathers and down Orris root Animal emanations Tobacco Dusts (house or occupational) Drugs (ipecacuanha, salicylates) Insecticides (pyrethrum, derris, nicotine) Fungi Alternaria, Aspergillus, Hormodendrum or Cladosporium) Osmys or odours (scents, peeling new potatoes, passing a fish, cooking legumes, handling soap powders)
- II INGESTANTS Foods (wheat, eggs, milk, chocolate, tomato, nuts) Drugs (aspirin, iodides, quinine)
- III PHYSICAL AGENTS Cold Heat Light
- IV INFECTANTS Bacteria are rarely sensitizers

The non-specific irritants include strong smells, bright lights, tobacco smoke, petrol or oil fumes, sulphur fumes from stoves, chlorine in pools or water

Helpful points in the diagnosis of the allergic nose include (i) a personal or family history of allergy, (ii) the typical pale, boggy mucous membrane, with a mucoid discharge, and the rarity of infection before surgical intervention, (iii) the allergic salute and nose wrinkling, pressure inward and upward on the tip of the nose, or drawing the alae nasi apart by muscular movements of the lip upwards or to one side, separates the turbinates from the septum and promotes the easier passage of air, (iv) positive skin reactions, (v) the nasal smear test for eosinophils or a blood eosinophilia, (vi) X-rays of the sinuses with or without lipiodol instillation showing opacities due to thickened membrane, and (vii) the immediate temporary response to adrenaline, ephedrine or benzedrine

The treatment of the allergic nose should be primarily from the allergic aspect The patient's general health should be improved, encouraging adequate sleep and exercise, fatigue, emotion and chilling of the body's surface should be avoided, the basal metabolism may need raising by thyroid therapy, and any flatulent indigestion improved by hydrochloric acid administration

The specific irritants should be removed Feathers, down and horsehair in the bedding should be replaced by air, spongy rubber, kapok, flock or vegetable down Orris root free cosmetics (Elaquisite Brand, Bencard) should be used, and animals banished from the living rooms and bedroom Sensitivities to house and occupational dusts, fungi, insecticides and pollens can be overcome by a course of desensitizing injections using specific solutions mixed for each case, or by the Mixed Inhalant Solutions or by the Combined Pollen Vaccine (if pollen sensitive as well) of Bencard, Gorgate Hall, Dereham, Norfolk The injections

George Bray

are best given as rapidly as possible, from several times a day in a nursing home to one each 2-3 days by the general practitioner. Non-specific desensitization (bacterial vaccines, peptone, milk, sulphur, histaminase or autohæmotherapy) is of no constant value. Mechanical or chemical irritants (irritant smokes, fumes, smells, gases, perfumes and paints) should be avoided.

Small doses of adrenaline hydrochloride solution (3-5 minims) subcutaneously or ephedrine by mouth (gr. $\frac{3}{8}$ - $\frac{3}{4}$) night and morning will help to relieve symptoms, and adrenaline, ephedrine 1 per cent. and neo-syneprine hydrochloride $\frac{1}{4}$ per cent. sprays and drops, or benzedrine or carbon dioxide gas inhaled will act beneficially locally. Cocaine and menthol deaden the subjective symptoms, but do not lessen the blockage so should not be used. Calcium by mouth is useless, and in large doses intravenously may cause only a slight vascular constriction. Endocrine therapy appears to help some cases, especially thyroid in "cold" people, and ovarian extracts in women about the menopause, some observers suggesting a reflex action, probably chemical, between the sex-glands and the nasal mucous membrane.

In surgical procedures conservatism is the keynote of treatment. The surgeon should realize that bacteria rarely penetrate an allergic membrane, and so purely allergic noses become infected with extreme infrequency in the absence of interference from without, and polypoid noses are even very resistant to infection. Intranasal abnormalities as causes of symptoms are the exception rather than the rule; if the swollen membrane can be diminished by allergic treatment, the abnormality ceases to cause undue symptoms. Turbinectomy allows cool unfiltered air to enter the bronchial tree, and causes an exacerbation of bronchial symptoms. Submucous resection of the septum is comparable to an emergency tunnelling by a rescue squad, of great immediate value when time is pressing, but not of much benefit when more permanent measures can be introduced.

Besides clearing the airway the aim of the rhinologist is to prevent the so-called "naso-pulmonary reflex". The dangers consequent on clearing the airway—the breathing of cold, unfiltered air—have been mentioned already. With regard to the naso-pulmonary reflex I am very doubtful if this plays very much part in the asthma associated with nasal abnormalities. I think that allergens are absorbed through the nasal mucous membrane and pass directly through the abundant lymphatics to the superior vena cava, then through the heart and pulmonary vessels to the lungs. The reasons I give for this new viewpoint are: (i) the injection of atropine does not benefit the asthma in these cases; (ii) the asthma often becomes more acute after the pressure and obstruction are removed; (iii) in the general asthmatic reaction following a violent skin test on the arm, the lymphatics begin to swell from the

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upper edge of the positive wheal, and the tide can be traced to the lymph glands of the axilla, and so to the lungs; this reaction can be prevented by the application of a tourniquet to the upper arm occluding the superficial lymphatic drainage, which would not hinder any nerve impulse; and (iv) the lymphatic spread of the allergic reaction was well seen in the case of cold allergy already mentioned. If the route from the nose to the lungs is a chemical one *viâ* the lymphatics rather than a nerve reflex consequent upon pressure, efforts of a surgical nature to prevent such a pressure reflex would be fruitless.

Certain other rhinological procedures are mentioned only to be deprecated though admittedly they may produce slight temporary relief. Cauterization, either electrical or with chemicals (carbolic or trichloroacetic acids) aims at destroying areas of membrane so that further swelling of the sites cannot occur—but as yet I do not know of any dermatologist who recommends burning of the skin as the treatment of urticarial wheals. Ionization induces sloughing of the old membrane, and the new membrane temporarily appears insensitive; but this soon becomes resensitized and any prolonged freedom is rare. If sinus infection exists matters may be complicated by the permanent closing of the ostia. Any constant beneficial effects of diathermy or radium treatments are also questionable.

Nasal surgery should aid the allergist to increase the defence mechanisms of the nasal mucous membrane rather than aim at the removal of large areas or the designing of elaborate drainage systems. Any surgical intervention should follow allergic therapy, and further allergic management succeed any operation. In pollen sensitive individuals operation should not take place during the summer months.

CONTRIBUTION TO A DISCUSSION ON NASAL ALLERGY

(EXCLUDING HAY FEVER)

By CYRIL POLSON (Leeds)

"THE wild relish of the too copious present" suggests that a backward glance may be opportune lest we concentrate only on "what was written yesterday and will be forgotten to-morrow."

Nasal allergy, in the form of hay fever, was first recognized as a clinical entity in 1819 when Bostock described his personal experience of "a periodic affection of the eyes and chest", a condition he later (1828) termed "summer catarrh". Bostock retains the credit for its first adequate description, even if he erred in the interpretation of its cause. *He denied its relationship to grass because he continued to have attacks when he visited Thanet, where he believed there was no grass in his view, therefore, summer catarrh resulted from exposure to the heat of the sun.* Elliotson (1831), who had also visited Thanet and seen plenty of grass there, rejected Bostock's explanation. Moreover, he shrewdly suspected that even a trace of the excitant was sufficient to produce an attack. He observed that these attacks were especially prone to occur during the flowering period of grass, and suggested that pollen was the excitant. Kirkman, early in the nineteenth century, found that when he inhaled pollen from sweet vernal grass, then in flower in his greenhouse, he had an immediate attack of hay fever. Proof was furnished by Blackley (1873) in carefully planned experiments, which were conducted over a period of fifteen years, with the author as the principal subject. He also invented, independently of Phœbus (1862), a method which demonstrated aerial distribution of pollen. This is still the basis on which pollenometric charts are constructed, although his kite has since been replaced by the aeroplane (Sheppegrell, 1925). Blackley made the earliest skin tests for allergy when he noted reactions caused by rubbing pollen into scarified areas of his skin. The value of his work was soon recognized for Morell Mackenzie (1884) spoke of it as "a model of scientific investigation". Growth in the scope of investigation has left this judgment unchanged, and Hurwitz (1929-30) declared that Blackley's researches had "no peer even in our own time". After yet another decade, during which much more has been written on allergy, that view holds true.

Sensitivity to excitants other than grass occurred in one of Elliotson's patients, whose attacks were associated with contact with rabbit fur.

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Salter (1864) also described his personal reactions to cats and found that these arose from contact with the fur but not by bite or from the saliva of cats. Ipecacuanha powder was early recognized (Walshe, 1854; Watson, 1857) as a non-seasonal excitant, although rarely described in recent years. (Peshkin's case (1920).) Many other excitants are now recognized, with wheat and orris root as principal members of the respective groups of ingested or inhaled excitants.

The idea that nasal disease was an important cause of allergic attacks was founded on Voltolini's (1871) claim to have cured asthma by the removal of nasal polypi. (He is often credited with success in eleven cases but "*Die Anwendung*", which is usually cited, contains an account of only two, one in the text and a second in the appendix.) Much discussion has centred round the value, or lack of it, of surgery in allergy. Francis (1902, 1904) severely criticized its value, whereas Dundas Grant (1913, 1931) remained convinced, after "every reasonable allowance for rhinological enthusiasm", that surgery was of value. It seems that the present consensus of opinion is against surgery in nasal allergy or, if it be undertaken, it should be accompanied by suitable medical treatment of allergy.

The demonstration by Brodie and Dixon (1902-3) that stimulation of an area on the upper and posterior part of the nasal septum caused bronchial constriction has proved "the keystone" of a veritable arch, the asthmogenic area. This sensitive area has since been appreciably extended. Haseltine (1928) rediscovered it in 1910, unaware of Brodie and Dixon's work, and included in this area the ethmoid, middle turbinate body and the adjacent portions of septum and outer nasal wall. Adam (1926) referred to it as a trigger area and added the septal tubercle. It is now believed also to extend backward to the sphenoid body and may include the sphenoid cavity (Bray, 1937). The inferior turbinate body is still outside this area, although J. N. Mackenzie (1883) found that stimulation of the nasal interior, to evoke a cough reflex, was most successful when the posterior end of the inferior turbinate bone was probed; the adjacent portion of septum was appreciably less sensitive.

Delay in the invention of biochemical tests is largely responsible for the passing of over 30 years between Ringer's (1864) observation, that urinary excretion of urea and chloride was impaired during asthmatic attacks, and that of Murdoch (1901), who discovered apparent achlorhydria in three out of five asthmatic patients. Since then a comprehensive biochemical investigation of allergic subjects has been made and few laboratory investigations have not been employed. Few authors, however, have examined a series of patients comparable to Bray's (1937) 2,000 gastric analyses in allergic children, or even his (1931) initial series of 200 investigations. Too often it has happened that "no sooner is a paper published describing some constant finding in a series of cases

than another series of observations is published repudiating it". As Bray has suggested, this conflict arises largely from generalizations based on scanty evidence, or faulty technique.

Comprehensive studies of the histopathology of nasal allergy are few, mainly because of the understandable scarcity of biopsy material and the disadvantages of autopsy specimens. The latter, however, afforded Huber and Koessler (1922) opportunity to make a detailed histological study of the lung in asthma. Nasal changes in allergy are described and illustrated in detail by Hansel (1929-30) and Munro Cameron (1935); the account by Eggston (1942) is not yet available.

The recognition of excitants, other than pollen, has of necessity enlarged the terminology. Admittedly the final choice of terms must await precise determination of the cause or causes, but there is room to reject certain now current. It is generally accepted, for example, that nasal allergy is no "ordinary inflammation" and therefore all "rhinitis" labels might well disappear. It would relieve an already overloaded group for which Sajous's plea in 1895 has been in vain. "Atopy" and "atopic rhinitis" are doubtless modest confessions of ignorance of cause, but a start might be made by rejecting these terms together with "rhinopathia chronica incretoria" (Haas, 1935), which has, however, received little support. "Allergic coryza", approved by Bray, or "nasal allergy" appear wholly satisfactory for present purposes.

Biochemical aspects of nasal allergy

These investigations were fully reviewed by Bray (1937) and the present purpose is to discuss only the results of gastric analysis, the blood sugar content and liver function tests in allergy.

GASTRIC ANALYSIS

Deficiency of hydrochloric acid in the gastric juice of allergic patients was first demonstrated by Murdoch (1901), who found apparent achlorhydria in three out of five asthmatic patients. Other early observations (Speithoff, 1908, and Ehrmann, 1918, 1922), concerned acid deficiency in patients with skin lesions of "allergic" type. Bray (1931, 1937) and Loveless (1935-6) have reviewed the literature and their contributions, together with that of Gillespie (1935) are the basis of the present discussion. Bray continued in 1937 to rely on findings in 200 analyses of 1931, and it is therefore accepted that the former conclusions were confirmed by his larger series of 2,000 analyses. He found distinct hypochlorhydria in allergic children, the observation being controlled by analyses in 50 non-allergic children. Amongst the allergic group

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a "complete absence of free hydrochloric acid" was observed in 9 per cent, an unequivocal hypochlorhydria in 48 per cent, and mild hypochlorhydria in another 28 per cent. This was accompanied on most occasions by a distinct excess of mucus. Although its precise incidence was not stated, excess of mucus was sufficiently common to be included by Bray in a representative chart of gastric analyses in allergic children. Low acidity in the group of controls was seen at most in only 20 per cent of the children. Bray also showed that the response to Ewald and Cheney meals was similar and Neale (1930) found that the 7 per cent alcohol meal is an adequate stimulus of gastric secretion in the child. It is reasonable, therefore, to compare Bray's results with those of other observers, although Gillespie raised objection to this on account of the test meal employed.

Loveless submitted 138 allergic patients, of whom 98 were asthmatics, to gastric analysis, equal numbers of adults, aged over 19 years, and children were tested, the sexes were equally represented. Control of this experiment was provided by the findings in healthy persons, determined by Vanzant and his colleagues (1933), and by Wright (1924) and Bray (1931) in healthy children. Subnormal gastric free acidity occurred only in adult allergic males, and contrary to Bray's findings, a distinct hyperacidity was found in allergic children. The results obtained were: adult males -9.7 clinical units (-194.0 weighted deviation), adult females, $+3.1$ units ($+133.3$ w d), female children, $+11.7$ units ($+257.4$ w d), and male children, $+15.5$ units ($+728.5$ w d). There were only six instances of apparent achlorhydria, histamine was not used to determine whether this was due to inability to secrete hydrochloric acid.

Gillespie (1935) also found that amongst 109 asthmatic patients, low gastric free acidity was present in those aged less than 15 years but a second peak occurred in patients at about middle age. The average incidence of low acidity in her series was 51.5 per cent.

The discrepancy, which exists between the results of Bray and those of Loveless, is notable but, unlike some of the other biochemical contradictions, it is capable of explanation. Loveless made a comprehensive search for the cause of low free acidity, observed by others, and discusses a dozen possibilities. It is probable that low results are, in part, influenced by technical factors, for example, the manner of preparation of the specimens for analysis and the choice of end point in titration. These, however, are of less moment than the time relation between the analysis and the last allergic attack and also the amount of mucus in the stomach during the test. Ten of the 31 patients found by Loveless to have low gastric acidity had an asthmatic attack during the test. She instanced a boy who, when first tested, had been free from asthma for several weeks, he then had but a trace of mucus in the gastric samples b

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when re-tested shortly after a severe attack, "great excess" of mucus was found. The acid content of the gastric juice on the first occasion was +12 units but, on the second, was only -6.5 units.

The paramount factor in creating low free acid readings, as was appreciated by Bray, is an excess of gastric mucus. From time to time, in my department, when routine test meals showed much mucus and low acidity, their repetition, after gastric lavage to dislodge the mucus, invariably demonstrated more free acid in the subsequent test samples. Knott, Oriel and Witts (1930) described two allergic patients who had apparent achlorhydria when first tested, but after gastric lavage with hydrogen peroxide, each secreted free hydrochloric acid; in one there was hypochlorhydria and the other had a high normal acidity. A similar experience is recorded by Loveless, who repeated gastric analysis on an apparent achlorhydric, substituting alcohol as the test meal; a small amount of free hydrochloric acid was then found in the test samples. Loveless also found that although acidity tended to be high in general, hypochlorhydria occurred in the group of 31 patients whose samples contained an excess of mucus. In this group the acid level was -15.5 clinical units, below the average for 120 allergic patients.

The manner in which mucus lowers the results has been described as either mechanical, obstructing the ducts of the acid secreting glands, or chemical (Bray, 1937). There is evidence that mucin can neutralize an appreciable amount of hydrochloric acid. Fogelson (1931), who proposed the treatment of peptic ulcers with powdered mucin, found that 1 gm. of the powder neutralized 15 c.c. of 5 per cent. (approx. N/10) hydrochloric acid.

It seems improbable that an innate error of secretion is a material factor. Absence of free acid is probably only apparent, and except, perhaps, Criepp and McElroy (1928), who did not specifically mention the use of histamine, but speak of achylia, in addition to achlorhydria, none of the authors appear to have used it. Achlorhydria in normal children is probably rare; no instance occurred in Neale's (1930) series, when he evolved a technique for histamine test meals in children. A histamine test meal, as Neale then concluded, is the only adequate test of true achlorhydria or achylia gastrica. (Some authors, e.g. Loveless, use the latter term to imply the absence of pepsin, as well as an apparent absence of free hydrochloric acid.)

Although chronic gastritis may be responsible for an excess of mucus in the gastric juice of adults, it is unlikely to play a part in children (Bray). It may account for the hypochlorhydria at middle age, observed by Gillespie. In children, the close proximity of a recent asthmatic attack is the most likely cause of excess of mucus in the stomach. Since children do not usually expectorate, this excess of mucus is believed to be, in the main, swallowed sputum or nasal secretion.

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BLOOD SUGAR CONTENT

A low fasting concentration of sugar in the blood of allergic patients was first demonstrated by Malone (1929). Estimation by Folin's method showed that this level in 15 asthmatic patients ranged from 68.9 to 80.1 mgr./100 c.c., whereas the normal range was from 90-120 mgr. Although Osman (1929) gave no details of the blood sugar content he found that empirical doses of glucose, short of causing acetonuria, were followed by improvement in four cases of infantile eczema. H. C. Cameron (1929) spoke of hypoglycæmia in allergy, but only in general terms. Black (1933) experienced severe sugar hunger during an attack of hay fever, and then found that his blood sugar content was only 67 mgr./100 c.c. This led him to examine 100 allergic patients in whom he found there was hypoglycæmia when fasting; their blood sugar content was then below 80 mgr. in 57, and from 81-90 in another 33 patients, at a time when they were not suffering from an attack. Twelve of these patients, whose fasting concentrations were from 61 to 80 mgr., were subjected to glucose tolerance tests, and the results suggested that there was an increased sugar tolerance. But the test dose of glucose was 100 gm., and Harrison states these larger doses tend slightly to prolong the curve to the right. The principal evidence, to date, is a series of observations by Payne and Bray (1937) on 55 allergic children, controlled by a like number who were not allergic. The fasting blood sugar concentrations, in the two series averaged 86 mgr. and 104 mgr., respectively. The range in the allergic series was from 58-110 mgr. of whom 36, or 65 per cent. were below 90 mgr. and 15 were below 80 mgr. In the control group the range was from 90-110 mgr. Crip (1931-32), on the other hand, found no abnormality in the blood sugar content of patients with urticaria. Harrison (1939), when discussing the effect of age on the blood sugar content in healthy persons, stated that a fasting level of from 60-80 mgr. is frequent in infancy. It appears, therefore, that a final conclusion on this aspect of allergy must await the presentation of more evidence.

LIVER FUNCTION IN ALLERGY

Payne and Bray (1937) examined liver function in 55 allergic children by means of several tests, including the lævulose tolerance test. The latter appeared to demonstrate abnormality in 23 of these patients but in 21, as judged by the illustrative graph, the results were only just outside normal limits. It is usual to accept an increase by over 30 mgr./100 c.c. in blood sugar content during the test as evidence of liver dysfunction. The increase in these 21 patients appears to have been by little more than 30 mgr. and a return to the fasting concentration occurred at the end of the test.

Barber and Oriel (1928) conducted a few tests to assess the effects of a rich protein meal on the amino-acid nitrogen content of blood, but the results did not differ appreciably as between allergic and control subjects. The meal caused an increase in amino-acid by 1.2 and 1.4 mgr. in two allergic patients and by 1.0 mgr., 0.8 mgr., and 1.6 mgr. respectively, in three controls.

The demonstration of minor grades of liver dysfunction is notoriously difficult. The many tests of liver function indicate that few are of great value and, as Harrison says, the current tests of liver efficiency are disappointing. When they were applied to experimental liver necrosis, it was found (Polson, 1933, a and b) that even an amino-acid tolerance test, apparently the most reliable, yielded positive results only in the presence of appreciable liver damage; the lævulose tolerance test was uncertain in its results under similar conditions. Experience of the lævulose test under clinical conditions has also shown that positive results are likely to occur only when grave liver damage exists. It is difficult to believe that the hay-fever patient, or even the asthmatic, ever has liver damage on account of the allergic condition alone. There is nothing to suggest it from their general health between the attacks or even during them.

MORBID ANATOMY

Satisfactory inspection of the nasal structures is practicable at post-mortem (Pickworth, 1932 and 1935; Polson, 1942), and adequate material for microscopy can be obtained, but on most occasions, its value is impaired by the lack of pertinent clinical information. Except when death is due to nasal cancer, it is usual in a general hospital that major disease elsewhere in the body has completely dominated the clinical picture.

In acute nasal allergy, the nasal mucosa has a boggy consistence, and is of pinkish-grey colour, and there is a profuse mucinous secretion rich in eosinophils (Hansel, 1929-30; Burhmester, 1935; Harris and Thomas, 1941). Rarely the discharge is of a gelatinous character, as described by D. B. Kelly (1935) in a man of 37, who was sensitive to horse serum and had hay fever. The patient's left nasal fossa was occluded by a tough green jelly-like membrane, rich in eosinophils, and containing some plasma cells and inspissated mucus. Burn Murdoch's patient (1894) had a similar incurrent "fibrinous rhinitis". A corresponding change was seen in the eye of a former colleague, who had had eczema, and now suffers from periodic attacks of "conjunctivitis".

Nasal allergy may be unaccompanied by visible intra-nasal disease, as described by Howarth (1933), in a family of four children, each of whom had vasomotor rhinitis. No structural abnormality was found by Poulsson (1895) in his patient, who had hydrorrhœa nasalis, although

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about a litre of fluid was secreted daily during the attacks. The rate of flow, which began on arising and continued until 2 a.m. next day, was so great that the patient was compelled to sit quietly and let it drip into a basin.

The present observations are based on only 140 examinations of the nasal structures at autopsy, and, therefore, the incidence of the abnormalities cited is only provisional. It has been somewhat surprising to find that only about half of the subjects examined were without naked eye intra nasal abnormality, and unsuspected sinus empyema was found in 16, or over 10 per cent. Nasal mucous polyps, however, were uncommon and only seven instances, of which two were equivocal, or at most slight examples, were seen. This is an incidence of at most one in 23 bodies, which agrees with Heymann's experience of one in 28 rather than that of Zuckerkandl, who found nasal polyp present in 39 of his 300 bodies, an incidence of about one in 8.

Changes of the kind usually ascribed to allergy, including nasal polyp, antral polyp or œdema of the sinus mucosa were relatively common. At times suppuration was co-existent (Table I). Antral

TABLE I

NAKED EYE ABNORMALITIES IN A SERIES OF 140 NASAL STRUCTURES SEEN AT POST MORTEM

Sinus empyemas	16 of which 10 were antral 4 sphenoid one frontal and one frontal and antral
Sinus mucosal œdema	7
(Sinus œdema with empyema)	10 including 4 of pan sinus œdema)
Nasal mucous polyps	6 cases and one associated with nasal cancer
Sinus mucous polyps	16
Septal deflections (severe) or crests	12
Nasal cancer	3
Hyperplasia of the inferior turbinate bodies	3
Osteoma of ethmoid sinus	1 fracture of nasal interior 1 absent sphenoid sinus 1 submucosal hæmorrhages in lymphatic leukæmia and epistaxis in chronic nephritis 1 example of each = 5 cases
Normal nasal structures	72

polyps were particularly common and two types were seen. Most often the polyp or cyst resembled a blister of the mucosa. It had a thin covering, readily broken, when clear colourless fluid of watery consistence then escaped. It was coagulated, and became opaque and white, when intact polyps were fixed in formal saline. Most of these polyps were from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter, single, and situated at variable points on one of the walls of the antrum. Occasionally the polyps were bilateral and at times they were multiple on one side. The second type of polyp was similar, except that it contained opaque yellow material resembling pus, which however, was amorphous under the microscope and sterile on culture.

The severity of œdema varied appreciably. Usually it caused thickening of the mucosa to about 2-3 mm.; in a few instances the mucosa was about 6-10 mm. thick and the sinus reduced to about half the normal size; rarely the sinus was filled with gelatinous or glairy material, sometimes of light brown colour. Appreciable œdema of the mucosa, which was thickened to about 3 mm., accompanied sinus empyema in ten of the 16 specimens.

Histopathology of Nasal Allergy

When the normal mucosa of the nose is described, a basement membrane is usually mentioned, but difference occurs regarding its position. Most authors imply that it is a structure between the mucosa and the adjacent bone. The term gives a false impression for there is no distinct membrane in this position. At best it is a zone in the tunica propria where connective tissue is denser than elsewhere. Van Alyea's view that the zone "hardly deserves to be separated as an anatomic entity" is supported by my observations. Moreover, the term "basement membrane" has a specific connotation, and concerns the delicate limiting membrane usually present between epithelium and the adjacent stroma. If the term be retained, it should be used as employed by Schall (1933) to indicate a membrane between the nasal epithelium and the tunica propria, although this is difficult to identify.

Most of the nasal material now examined, even in the absence of naked eye disease, presented evidence of low grade inflammation. A mild infiltration of the tunica propria by lymphocytes and plasma cells is probably of general occurrence and, like anthracosis of lung, must be accepted as constant in the town-dwelling adult and a reaction to dust or soot pollution of the air. It is rare, therefore, that a change which is exclusively allergic may be seen. Although Hansel (1929-30) appreciated a difference between ordinary inflammation and allergic manifestations, the inclusion of lymphocytic, plasma cell and round cell infiltration in his description of the allergic mucosa suggests that he had not discounted this "normal" factor.

The outstanding changes which appear to characterize the "allergic" mucosa are eosinophil infiltration and œdema of the tunica propria. Eosinophils are also seen amongst the epithelium and pass into the nasal secretion. Opie (1904) described this in cavies, when it occurred in the absence of any detectable abnormality, a point to recall when animal experiments, involving histological study of the tissues are undertaken. Cameron (1935) divided the nasal changes into four groups, two of which were exclusive to allergy. The acute phase, his type three, as seen in those who die in status asthmaticus, was characterized by eosinophilia of the tissues, but especially in the superficial layers of the tunica propria. The chronic phase (type 4) was dominated by œdema of the tunica

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propria and although accompanied by eosinophilia, the latter was less intense than in acute allergy. Neutrophil polymorph infiltration or lymphocytic and plasma cell infiltration was indicative of bacterial infection.

Secondary changes, which may be of allergic origin, include thickening of the deep layer of the tunica propria (the "basement membrane" or pseudo periosteum (Wagner 1933-4)), hyperplasia of the respiratory and glandular epithelium, and increase in the number of goblet cells. These changes are likely to occur only in chronic lesions. Sclerosis of bone, when it acquires an ivory consistence, is an inflammatory and not an allergic change but rarefaction of bone, for example in the antral wall, or in the ethmoid and turbinate bones, was present and ascribed to allergy in Hansel's and Cameron's specimens.

TISSUE EOSINOPHILIA

The earlier view that eosinophil leucocytes in allergic tissues were derived exclusively from bone marrow has appeared to some authors an inadequate explanation, the number of eosinophils present were to be accounted for only on the basis of local production. Others, including Bezançon and Bernard (1930), believe that tissue eosinophil leucocytes are derived from both sources. According to Opie (1904), Ehrlich himself had suggested that, in the frog, eosinophil leucocytes might be derived by a process of transformation of connective tissue cells. Exclusive origin from the bone marrow was, however, accepted by Opie (1904) and Huber and Koessler (1922), a view here accepted because evidence in favour of connective tissue formation of eosinophils is, at best, distinctly slender.

A notable accumulation of eosinophils, whether in connective tissues or bone marrow, is no more than evidence of storage, a point made by Muller and Rieder (1891). Signs of cell division and the presence of primitive eosinophil white cells, of myelocyte type, are another matter. Except in leukæmia, these are to be seen only in the bone marrow. Eosinophil leucocytes in connective tissues differ in no way from those of the blood (Opie, 1904). Nor does it appear that anyone has yet published evidence of eosinophil mitosis, or primitive eosinophils, in allergic tissues. Mononuclear eosinophils, present in small numbers, were recognized by Huber and Koessler, but as discussed later, these are degenerate eosinophils. The coincidence of tissue eosinophilia with eosinophilic activity of the bone marrow was noted by Huber and Koessler.

The occurrence of distinct tissue eosinophilia in the absence of blood eosinophilia has proved a principal difficulty in accepting the bone marrow as the sole source of eosinophil leucocytes. Heineke and Deutschmann (1906) have shown that an abundance of eosinophil leucocytes may be mobilized, although their percentage in the blood is within normal

limits. There was a fall from 2.1 to 0.4 per cent. of blood eosinophils during their patient's allergic attack, whereby some 126 millions of eosinophils per litre of blood were removed from the circulation, and in the absence of an initial blood eosinophilia. Huber and Koessler also found that tissue eosinophilia in asthma is not a uniform change, being more intense in some areas than in others. In consequence the number of eosinophils withdrawn from the circulation, to produce tissue eosinophilia, is probably much less than might be anticipated.

Two types of eosinophil leucocytes have been described in allergic tissues, namely, polymorphonuclear, as seen in the blood, and a mononuclear form (Huber and Koessler, 1922; Cameron, 1935). Although Cameron appreciated that the technical processes involved may have been, in part, responsible for this distinction, he concluded that the duration of the lesion was indicated by the type of eosinophil present. In his view, acute allergic changes were associated with polymorph eosinophils, whereas mononuclear eosinophils were a feature of chronic lesions. Technical procedure plays an important part in modifying the fine structure of polymorph leucocytes and when celloidin sections are used, it is difficult to obtain them of much less than 15 μ m. thick. Huber and Koessler found that close scrutiny under high magnification resolved many mononuclear into polymorphonuclear eosinophils. They accepted a small proportion of the eosinophils as genuine mononucleated cells, but they regarded these as degenerate because these cells were no larger than healthy eosinophils and their nuclei were shrunken and pyknotic.

POLYP FORMATION

Since Köster (1881) demonstrated serum and the absence of mucin in nasal polyps, the neoplastic conception of their nature has become but of historical interest. There still remains, more especially amongst pathologists, appreciable support for the view that they are inflammatory in origin. Ewing (1940) regarded these polyps as one of "the purest examples of pseudo-tumor of inflammatory origin". It has also been suggested that their development followed lymphatic obstruction by inflammation, the process resembling that in elephantiasis (Watson Williams, 1907).

More recently clinical opinion tends to regard these changes as a manifestation of allergy. It may be that this is responsible for mucosal oedema. Microscopical evidence of ordinary inflammation is relatively slight, but in macroscopic empyema, there is at times only limited inflammatory reaction and much oedema of the sinus mucosa. Watkyn-Thomas (1939) admitted both possibilities, and classed nasal polyps amongst "reactionary hyperplasias". Scott Williamson (1932) ascribed their origin primarily to glandular hyperplasia, instigated by excessive functional stimulation. Yonge (1907) stressed oedema as the

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starting point of nasal polyps, and believed glandular dilatation, secondary to inflammation, predisposed to mucosal œdema. As yet the precise cause, or causes, of œdema have to be demonstrated, but this change is an essential phase in the development of nasal polyps. Other factors include differences in the texture of the nasal mucosa, anatomical situation, and traction by nasal secretion and gravity. Appreciable variation in the density of the tunica propria explains the greater frequency of severe œdema of the loose tunica of the ethmoid and its infrequency in the denser tunica of the septum. The upper regions of the nose are more influenced by traction from the flow of nasal secretion and the effects of gravity than the lower. These factors explain the high incidence of polyps in the upper nose and their rarity, if not total absence, from regions below the level of the lower border of the middle turbinate body. Once an area of mucosa has prolapsed its own weight will tend to hasten the formation of a stalk and, in turn, constriction of the structures in the stalk, thereby exaggerating œdema in the polyp. It may be that antral polyps are sometimes areas of the mucosa which have failed to return to normal during the resolution of diffuse œdema of the mucosa.

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NASAL ALLERGY

(EXCLUDING HAY FEVER)

By MYLES L. FORMBY (London)

It is essential that we should have a clear understanding of the clinical entity which we are about to discuss. Here, at the very outset a difficulty presents itself. The predominant symptom or sign varies greatly from case to case and in few is it possible to determine the principal ætiological factor from a clinical examination. If one excludes the clear cut cases of hay fever, asthma, migraine, urticaria, suppurative sinusitis or bronchiectasis there remains an enormous group whose nasal symptoms are similar to these but where underlying condition is less evident. These are the cases of allergic rhinitis, or at least each should be regarded as such until proved beyond doubt to be otherwise.

In spite of many facts that have been accumulated the precise ætiology remains undiscovered. Age and sex throw no light on the problem. Unfortunately it has not been possible for me to obtain the age figures for cases I have seen and the figures indicating sex incidence are limited to private patients.

ALLERGIC RHINITIS (Private Cases).

1934-1939.

Diagnosis.	Total.	Male.	Female.	% Male.	% Female.
Uncomplicated	115	48	67	41·7	58·3
With Ethmoiditis	238	122	116	51·3	48·7
With formation of polyps	43	29	14	67·4	32·6
Asthma (no nasal symptoms or signs) ..	11	7	4	63·6	36·4
	407	206	201	50·6	49·4

Cases having some suppurative sinusitis are not included in this table. It is my belief that a large number of these cases of sinusitis are in the first instance uncomplicated cases of allergic rhinitis, but through unavoidable misfortune, neglect, or misguided surgical intervention, infection is superimposed.

Nasal Allergy

No useful purpose will be served by enumerating at length the various symptoms and signs presented by patients with allergic rhinitis. I will however read to you a brief account of one case which I regard as truly representative and which will serve to illustrate certain features, the importance of which I wish to emphasize.

In January 1943, Mrs F. D., age 50, complained of complete nasal obstruction, profuse nasal discharge and a fleshy lump presenting at the right nostril.

Previous History At school 2-3 colds a year. From age 20-25 working in the Civil Service she had a series of colds and a perpetually stuffy nose. Discharge was profuse and watery and sneezing was moderately troublesome. Her condition was thought to be due to the central heating in the building where she worked as her nose was clear at night and while she was on holiday. Married at the age of 26 for the first six months the watery discharge was terrible and then suddenly stopped. This cessation coincided with the onset of pregnancy. In all there were three pregnancies during the next seven years. She enjoyed good health with no nasal symptoms for eighteen years. At the age of 44 menstruation became irregular and in the same year she fractured her right scapula as the result of an electric shock. About this time (1937) she again became conscious of her nose which was stuffy and inclined to water. These symptoms were relatively mild until the spring 1942 when following the death of her daughter the nasal and post-nasal discharge became profuse, breathing was obstructed and she felt tired and heavy. After three weeks on a farm by the sea the nasal symptoms disappeared. The nose remained clear until October 1942 when she and all members of her household had "flu". Immediately following this the nasal obstruction returned and persisted and the discharge became profuse and thicker than previously.

On examination—A stout, rather pale, alert, intelligent woman. Both sides of the nose were completely filled with polyps those on the right presenting at the anterior nares. There was a large amount of yellowish-white mucopurulent discharge anteriorly and in the nasopharynx. The maxillary antra and right frontal sinus did not transilluminate and the X-ray appearances suggested gross thickening of the mucosa in these sinuses.

Operation (January 1943) General anaesthesia. Intra-nasally polyps removed, both middle turbinates polypoid, were removed, ethmoidal cells cleared, both sphenoids opened, bilateral antrostomy. No polypoid changes of inferior turbinates. Large quantities of thick ropy yellowish-white mucoid secretion throughout the sinuses. Separate specimens taken from antra, ethmoids and sphenoids. All sterile on bacteriological examination.

Histology of a polyp and mucosa from a middle turbinate showed intense eosinophil infiltration, absence of cilia and no evidence of inflammatory changes.

The outstanding and characteristic features of this case are

- (i) The long history, with exacerbations and remissions of symptom
- (ii) The influence of environment, centrally heated atmosphere and a seaside holiday both materially affected the symptoms

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- (iii) The close association of nasal symptoms with physical and mental stress.
- (iv) The influence of normal physiological changes, namely pregnancy and menopause.
- (v) The association of intercurrent infection.

In the case just quoted one might have been excused for beginning the story from October, 1942, the date the patient first gave for the onset of her symptoms. The picture would then be that of a patient, with a susceptible nasal mucosa, who developed in the course of an influenzal epidemic an acute nasopharyngeal infection. Three months later she is seen with clinically a pansinusitis and polypi. That this is *not* the true sequence of events is proved by the complete absence of demonstrable organisms in the sinuses three and a half months after the acute infection. This is no local disease of the nose but a general systemic disorder. In the present state of our knowledge it seems to me purely a matter of chance where and in what form this mysterious disease manifests itself. As far as the nasal manifestations are concerned I believe local infection plays no important part until it has been grafted into the upper respiratory mucosa by surgical interference. It is then a secondary infection and a complication and not a primary ætiological factor.

TREATMENT

Until we are able either to exclude or neutralize the effects of allergens, or to render susceptible individuals insensitive, we cannot hope to effect cures. The nearest approach to success has been achieved by desensitization in suitable cases and this has been described by Dr. Bray.

Much can however be done for these patients by preventive and palliative measures, and here a warning. The spontaneous variations which these cases undergo have already been mentioned. In assessing treatment it is difficult to avoid self-deception and sometimes criticism is levelled at a colleague or rival.

In recent years as a routine it has been my practice, with cases where no obvious preventive measure suggested itself, to prescribe full doses of colloidal calcium and vitamin D. Those whose symptoms were more severe were also given ephedrine hydrochloride, gr. $\frac{1}{2}$, twice daily by mouth and 1 per cent. ephedrine in normal saline as a nasal spray to relieve obstruction.

PALLIATIVE SURGICAL MEASURES

Dr. Bray has dealt with the minor procedures. Here also one must not be deceived by the effect of the operation *per se*. A teacher of mine when a junior colleague tried to impress him with the virtues of turbinectomy in the treatment of spasmodic rhinorrhœa, enquired if the

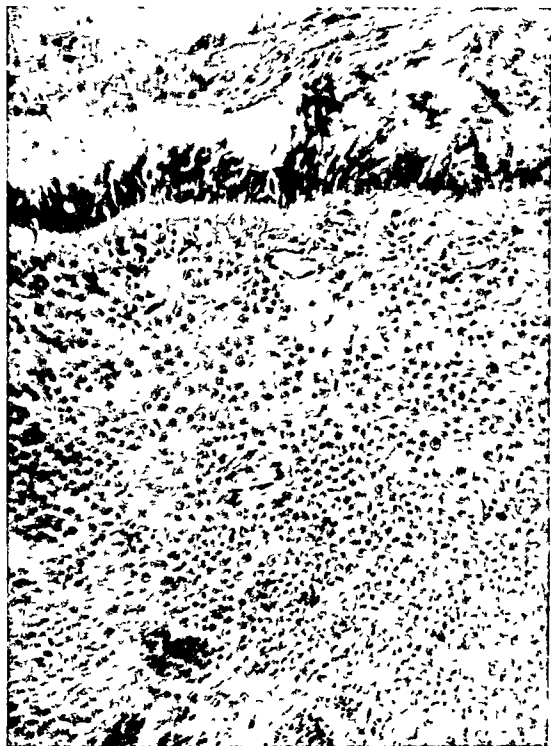


FIG 1.

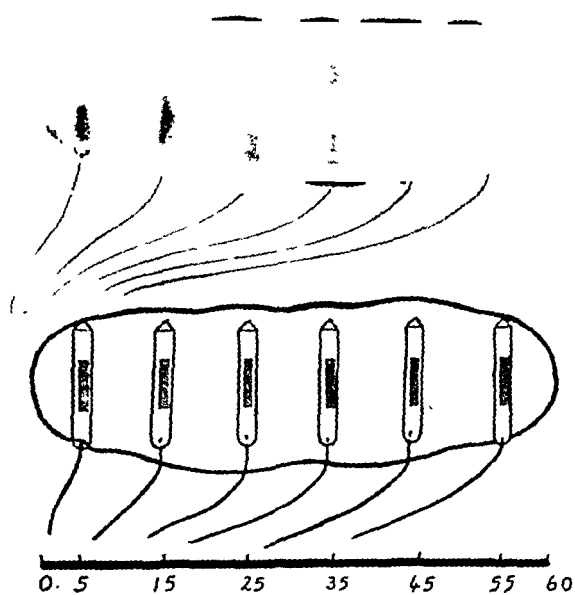
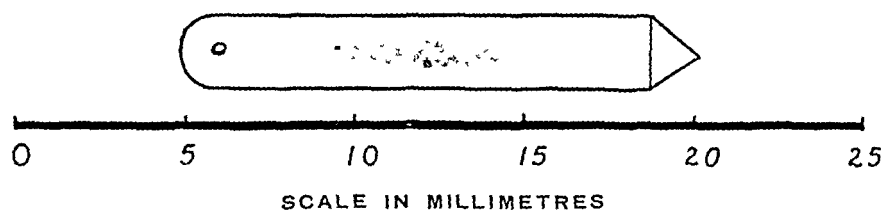


FIG. 2

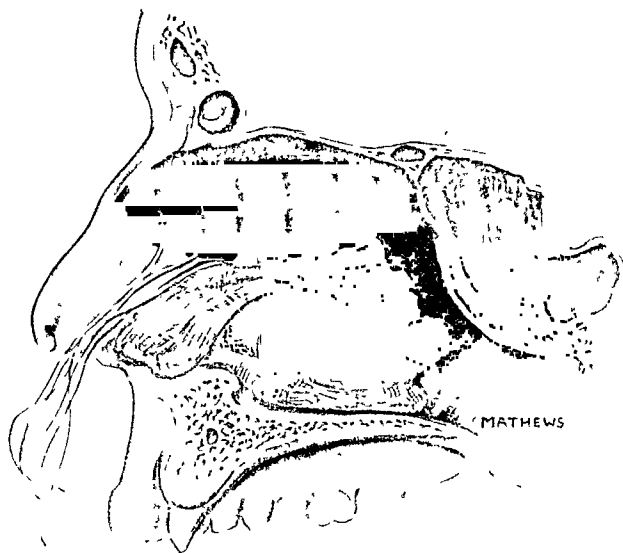


FIG 3

Nasal Allergy

exponent had tried the effects of amputation of the little toe. This facetious remark was intended to remind us that *any* operation may produce apparent improvement temporarily.

Many surgical procedures have been advocated to relieve polypoid degeneration of the nasal mucosa with complete obstruction. I will describe briefly a technique for the application of radium. This has been used in some thirty cases with recurrent polyps. With one exception (a boy, aged 12, in which this treatment failed completely), all had immediate relief, all had undergone previous operation, many had had multiple operations and in most secondary sinus infection was already present.

After spraying the nose with 5 per cent. cocaine each side is packed for half an hour with half inch ribbon gauze soaked in equal parts of 10 per cent. cocaine and 1 in 1,000 adrenalin. Under general anæsthesia a submucous resection of the septum is performed if its irregularity prevents easy access to either ethmoidal region. A bilateral intra-nasal ethmoidectomy and bilateral intra-nasal antrostomy is then carried out. Two pieces of dental stent, each shaped like a Lake's rubber splint, are next moulded to fit high up in the right and left ethmoidal regions. Into each piece of stent six 6.5 mgr. Radium needles are inserted vertically, the stent placed in position against the roof of the nose and held in position by filling the lower part of the cavity with one inch ribbon gauze soaked in liquid paraffin. The needles are left in position for seven hours (546 mgr. hours) and then removed by withdrawing the ribbon gauze and the stent with angular forceps, morphia having been given half an hour previously, if necessary.

Careful supervision for 3 to 4 days after operation is important if adhesions are to be avoided. A dense coagulum forms in the nose and must be removed daily. Regular spraying with liquid paraffin is advisable and if crusting and discharge are excessive daily douching with an alkaline lotion. Patients are generally fit to leave hospital a week after operation but should be inspected weekly for a month and then less frequently for 3 to 4 months.

The following are the details of the 12 radium needles employed :

RADIUM FOR NASAL POLYPI					
12 Needles (6 each side) for 7 hours.					
Strength	..	..	..	..	6.5
Length	..	..	..	..	15.0
Screen	..	..	..	..	0.5
Active Length	..	..	..	..	6.0

Dose 546 mgr. hours.

Unfortunately results can only be assessed from seventeen cases, the notes of the others not being available.

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CASES OF ALLERGIC RHINITIS WITH BILATERAL POLYPS TREATED WITH RADIUM
546 mgr. hours.

Case No.	Sex.	Age.	Date of Irradiation.	Condition at last Report.	Date of last Report.	Result.
1	F.	39	August 36	No recurrence. Very well.	August 42	Good.
2	F.	31	Sept. 36	Very well (Patient's letter).	June 41	Good.
3	M.	53	Oct. 36	In R.A.F. Occasional asthma. No polypi (Dr.'s letter).	June 41	Good.
4	F.	—	April 37	Perfectly well. Wishes not to attend (Patient's letter).	June 39	Good.
5	M.	40	April 37	Recent right Frontal sinusitis. No polypi.	March 42	Doubtful.
6	F.	26	June 37	No symptoms (Patient's letter).	April 40	Good.
7	M.	12	June 37	Blocked nose, perforated septum and swollen mucosa.	March 42	Failure.
8	F.	27	July 37	No recurrence.	Nov. 39	Good.
9	M.	25	Jan. 38	No polypi. Both inferior turbinals + bad asthma.	Nov. 41	Doubtful.
10	F.	32	March 38	Afraid nasal trouble returned. Cannot report (Patient's letter).	August 41	Doubtful.
11	F.	54	May 38	One small polypi. Right anterior ethmoid removed.	July 39	Doubtful.
12	F.	34	May 38			
13	M.	49	July 38	No recurrence, no symptoms except tinnitus	May 39	Doubtful.
14	M.	50	Nov. 38	No recurrence, headaches, no cause found	Feb. 40	Doubtful
15	M.	—	Dec. 38			
16	M.	66	May 39			
17	F.	53	June 39			

RESULTS.

Good	6	No report	4
Doubtful	6	Failure	1

The doubtful cases are probably successful from the standpoint of absence of recurrence of polyps. They have not been classified as good where the application of radium took place less than three years prior to the last report. Two patients developed asthma subsequent to irradiation.

PREVENTIVE TREATMENT OF CHRONIC OTITIS MEDIA AND SURGICAL APPROACH *VIA* THE CAVUM CONCHAE

By W. O. LODGE (Halifax)

GENERAL SURVEY

The preventive treatment of chronic otitis media is one of the most important problems in surgery. In Great Britain, as many persons suffer from chronic otitis media as flock to Blackpool on a Bank Holiday. It is inevitable that those afflicted should be incapacitated in one way or another; a discharging ear is certainly a social handicap. It is a bar to certain occupations—to mention an extreme case, that of midwife. Employment in the preparation of foodstuffs of all kinds, and visits to public baths are clearly undesirable. That chronic otitis media is one of the commonest causes of incapacity from military service is one of the major lessons of the war. The intracranial complications of the disease are calamitous; meningitis, brain abscess and sinus thrombosis take their toll of human life. Of those who survive operations for brain abscess a proportion develop epilepsy.

Chronic otitis media usually dates from infancy. This can be shown by X-ray examination. In a unilateral case whereas the healthy mastoid process is shown to be well pneumatized, the radiogram on the affected side usually shows scarcely any mastoid air cells, especially posterior to the curved line which indicates the position of the lateral sinus. It used to be held that this appearance was due to sclerosing osteitis, but contemporary thought inclines to the theory of arrest of pneumatization by otitis in infancy.* A poorly developed mastoid process implies a mucous membrane which is not resistant to infection.

Otitis in infancy ought therefore to be notifiable; it is as much a cause of deafness as ophthalmia neonatorum is a cause of blindness. It demands the most effective treatment, preferably admission to an open air balcony (if available) of a children's ward. Experience shows that if for example mercurochrome drops are applied by the parents, there is often no trace of the dyestuff in the depths of the meatus when the child is brought back with the complaint that the trouble still persists.

* A corollary is that if in a case of chronic otitis externa the temporal bones are well pneumatized, the tympanic membranes are probably intact. This is worth bearing in mind when the tympanic membranes are difficult to see and one is pressed for an immediate report.

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To trained nurses in hospital such treatment presents no difficulty; the ordered routine, balanced dietary and other therapeutic resources are effective in the majority of cases.

In certain fever hospitals in this country, it is still, unfortunately, possible for children to be kept as in-patients for as long as twelve months on account of chronic suppurative otitis media without having been seen by an otologist, but such mistakes are becoming rarer. The gap which commonly occurs in treatment on leaving school has been commented upon by high authorities. School medical officers have focused their attention especially upon the age incidence of measles and overcrowding; they regard chronic otitis media as a poverty disease. Surgeons, on the other hand, find in their daily routine that pyogenic bacteria are no respecters of persons. Pathologists lay stress on the intractability of mixed infections. The laity are probably nearer the mark, when they speak of good healing flesh. The right conditions may be present in one ear and not in the other. Age is not the only factor in the denominator of a formula for healing.

ROLE OF THE EUSTACHIAN TUBE

Professor Holmgren of Stockholm, first enlightened me concerning the functions of the Eustachian tube, which is not solely a ventilating shaft, but also serves the purpose of an outlet for the secretions of the mucous lining of the tympanic cavity, mastoid antrum and cells. When he passed a Eustachian catheter, he made a practice of inclining the head forwards during inflation, and often saw half a teaspoonful of fluid escape from the tympanum. Holmgren was no great believer in *hydrops ex vacuo*.

I have had opportunities of confirming his opinion; for example, in operations undertaken for oto-sclerosis or, rarely, when a healthy mastoid has been opened. The discovery of fluid, especially of greenish fluid in the mastoid antrum, would naturally indicate re-examination of the naso-pharynx. It is probable that many children with adenoids, suffering from deafness, have simple retention of fluid in the tympanum. In ignoring this function of the Eustachian tube, are physiologists making the same mistake as the ancients, who thought arteries contained air? Moynihan's phrase, "The pathology of the living" comes to mind.

How easily pneumatization could be arrested without active inflammation. It is not proposed to discuss in this paper antero-inferior or central perforations of the membrana tympani.

WHAT HAS SURGERY TO OFFER?

Let us now consider the hard core of intractable cases. It is idle to debate the relative merits of wet versus dry treatment, when the disease

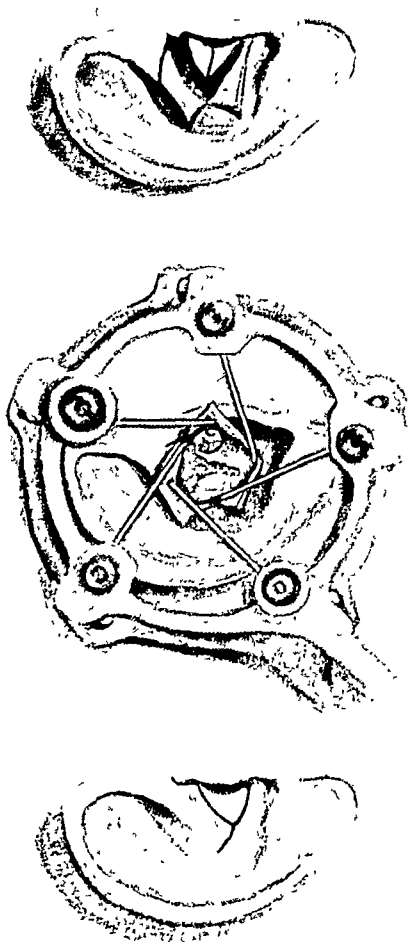


FIG. 1. General anesthesia optional

Incision After infiltration with novocaine and adrenaline a tri-radiate incision is made among the contours of the cavum conchae, with an extension forward between the tragus and the crus helices. A short flap based on the latter is reflected upwards, a triangular flap based on the meatal rim is reflected forwards and a third flap downwards. Some of the fibrocartilage and all of the subcutaneous tissue is excised. The respiratory is applied but the external auditory meatus is preserved intact until the conclusion of the operation.

Cruciate There is a perforation in the postero-superior quadrant. Granulations are present. The ossicles are intact. An operation of access is in progress. A conservative mastoid operation is facilitated by a special retractor. The aim is to produce a smooth walled cavity freely accessible to treatment. At the tip of the mastoid are cells in which the infection lurks, other outlying cells in the angle between the middle fossa and lateral sinus have been evacuated.

Drainage The meatus is finally slit throughout its length and held open by sutures. The upper and lower flaps curl inwards over the fibrocartilage, the upper one usually needs a mattress suture to keep it in position. The cavity is packed with antiseptic gauze and a dressing is applied. Further details are given in the text.

1

Preventive Treatment of Chronic Otitis Media

extends to the attic or beyond. To apply zinc ionization in a case of cholesteatoma is only likely to confirm the public in their well founded prejudice against tampering with the ear. A delicate operation, skilfully executed, and devoted after treatment will effect a cure in a proportion of cases. A candid observer followed up large series of operations for chronic otitis media in leading continental clinics and declared that only 46 per cent. were completely successful.

It is not surprising that mastoid operations have an evil reputation, and that the mere mention of one strikes a chill into the average heart. How can this percentage be improved? One obvious way would be by careful selection of cases. But the leading surgeons of the day sometimes succeed in one ear and not in the other, on the same patient. Some eminent otologists scarcely ever operate in chronic cases; they have enormous waiting lists of other cases which do not fill beds so long. Is there an inner circle of otologists who hold the keys of healing in their hands? An interesting but barren speculation! We mainly see each other's failures.

One way to increase the total number of operations to be performed is to refrain from making a post-auricular incision, just as blood transfusion can be popularized by refraining from cutting down upon the vein of the donor. The rediscovery of the transmeatal route has encouraged many persons to submit to operation even though they did not feel instinctively that the smouldering embers were ready to burst into flame.

All the patients ask is a dry ear without deafness or deformity. All surgery can offer is access; in other words, when the operation is completed, the treatment begins.

The time factor is important. One patient resumed work on the third day, but three weeks is the average period of in-patient treatment. If patients are scattered in half a dozen different hospitals; so much the less risk of cross infection.

Small cholesteatoma in the attic are most favourable, particularly if the mastoid is well pneumatized; provided disturbance of the ossicles be sedulously avoided, one will certainly be rewarded by a dry ear and good hearing. Cases with aural polypi or granulations are by far the most difficult, owing to the forward position of the lateral sinus. The facial nerve is likely to be exposed to injury in large cholesteatomas, but when paresis develops on the second or third day after operation, the prognosis is good. Facial paralysis is no more frequent after operation than without it.

The commonest cause of failure is over cicatrization. For this reason, the modification I have been performing late in 1943 has not been strictly transmeatal. The meatus has been most carefully preserved until the end of the operation, and then slit posteriorly. I have not had a stenosed meatus since adopting this plan.

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Cases are usually referred by their doctors because of otorrhœa ; if this persists, it is poor consolation to the patient to remind him that his hearing is as good or better than before the operation, or that he has now no reason to fear intracranial complications ; from his standpoint, the operation has been a failure. The choice between a conservative or radical operation is therefore an important one ; but for my part, if the ossicles are recognizable at all, I leave them untouched. Since a dislocation of the incus, however slight, may upset the hearing, one has to school oneself to avoid the slightest interference.* Yet it is extraordinary how good the hearing can sometimes be after radical operations. One of my patients who had had radical operations on both sides became eligible for permanent employment in the post office ; he could hear a stop watch behind the medical examiner's back. In another case where phenomenal improvement in hearing occurred after a radical operation, the labyrinthine fistula test was positive ; the patient was a soldier and continued to serve in a low category.

Improvement or retention of hearing is naturally much more consistent after conservative operations ; this is usually manifest when a radical operation has previously been performed upon the other ear. The object of otology is to make the deaf hear.

APPROACH TO THE MASTOID VIA THE CAVUM CONCHAE

Plastic flaps are made short and broad. A flap, such as that illustrated in my contribution in the *Journal of Laryngology and Otology* in September 1941, is too long and thin ; there is a risk of necrosis particularly if the temporal bone is heavily infected.† Further it appears to me at present that the external auditory meatus should be most carefully preserved and not displaced from its natural position. It is sufficient to slit it posteriorly.

It follows that the first incision should be V-shaped diverging forwards in the cavum conchae, about two or three millimetres behind the brim of the meatus. From the forward extremity of this incision, a cut is made in a forward and upward direction emerging between the tragus and root of the helix, where the fibro-cartilage is lacking. Another short incision runs upwards and backwards from the point of the V. Whilst these incisions are being made, the pinna is turned forward from time to time to reduce the risk of button-holing. The first flap to be raised is that which is based upon the root of the helix ; when it has been

* By way of further emphasis, let me parody Iago's words to Othello :

" But he that filches from me my incus
Robs me of that which not enriches him
And makes me poor indeed."

† No such complication occurred in the case described in that issue ; the patient's hearing was restored. He subsequently changed his occupation from inn keeping to contractor for aerodrome construction.

Preventive Treatment of Chronic Otitis Media

dissected up, a guy suture is inserted into it. Elevation of the short lower flap, and deepening of the V-shaped incision, paves the way for excision of most of the fibro-cartilage and muscular tissue overlying the mastoid. The raspator is vigorously applied, and a five-fanged self-retaining retractor inserted. The external auditory meatus is not slit up just yet, but is pressed forward by the retractor. This instrument has a cam action similar to that of the iris diaphragm. All the fangs or claws open simultaneously when an outer ring is rotated; one claw is longer than the rest, it compresses the meatus.

A conservative mastoid operation is carried out *secundum artem*, the utmost care being taken to avoid disturbing the ossicles.

After flattening the "bridge" until it is level with the floor of the meatus, and after making sure that any outlying mastoid cells have been evacuated, the meatus is slit and stretched open by two sutures, one above and one below. The upper suture fixes the corner formed by the junction of the longitudinal slit with the triangular incision which runs just outside the brim of the meatus, into an angle between the tragus and helix. This has the effect of widening the mouth of the whole cavity, which is packed with iodoform gauze or acriflavine emulsion. If the latter is used, it should not be continued for more than three weeks, otherwise there is a danger that eczema and perichondritis may develop.

In a certain proportion of cases, particularly where there is no infection, as in operations carried out in non-suppurative cases for oto-sclerosis, there is a remarkable tendency to *restituto ad integrum*. Healing is so complete that it is difficult even for an expert to see that any operation has been done. Cases, in which two or three mastoid operations have been performed previously, are the most difficult and the most liable to be followed by excessive cicatrization and keloid formation.

I am trying as far as possible to confine my operations to young subjects with unilateral disease, good hearing and no other physical defects. Small epitympanic cholesteatomas, which are rare, may be undertaken with confidence at any age.

RESULTS OF OPERATIONS

In approximately 250 cases operated upon since June 1939, for chronic otitis media, in several hospitals, there has been one death, from a purulent pre-cerebellar abscess. To avoid complications, it is essential to make sure that one is not dealing with a dead labyrinth; it is a good rule to make a test with Bárány's sound box. The effect of a waiting list is noteworthy; often a delay even of a few days revealed that trouble was impending, hence the instinctive readiness to submit to operation.

Facial paralysis was never seen immediately after operation, but developed within the first week in three cases; in each of these full recovery was made. A commoner complication, apt to appear whenever

W. O. Lodge

the inner table was eroded, was vertigo and nystagmus to the opposite side ; this never failed to respond to rest, sulphonamides and sometimes a lumbar puncture.

With regard to the percentage of dry ears, one cannot assess results for from three to six months after operation, and patients are remarkably mobile in wartime. Patients often state that their ears discharge when they are healed ; I have heard the most brilliant results achieved by colleagues belittled in this manner. There is no doubt that each successful case is a cause for rejoicing ; sundials and surgeons only count the happy hours.

In bilateral neglected cases with osteophytes in persons of low vitality, it is best to make no promises.

I hope at some future date to publish some more exact statistics. There is no doubt that the last hundred cases will show a higher proportion of successful results. The avoidance of a retro-auricular incision helps to attract good risks.

Before I took steps to prevent it, a number of patients who had undergone such operations were passed Grade I for the Navy, Army or R.A.F. and served on various fronts, but on volunteering for flying duties or applying for commissions, found themselves back in civil life, owing to current regulations. If the operation could be so much improved that the cavity could be systematically neglected without ill effects, no doubt the regulations would eventually be altered.

The following were among a dozen post-operative cases shown at clinical meetings of the Leeds and West Riding Medico-Chirurgical Society.

CASE I.—S.N., aged 19, boiler maker, referred by Dr. Hornby, had chronic otitis media (right) of ten years duration. There was a posterior perforation and granulations were present. The left tympanic membrane was cicatrized. He had rightly been rejected for military service by the Medical Board. A conservative operation was performed in October 1942. The cavity is healed and he can hear a whisper with either ear. There is no post-auricular scar. The new meatus is guarded by miniature upper and lower earlids of pleasing appearance. These are quite inconspicuous, and so far cerumen has shown no tendency to accumulate, though it is present in normal amount.

CASE II.—Mrs. L., aged 46, was referred by Dr. Clegg, of West Vale, on account of pus and granulations in the left ear of about twenty years duration, and vertigo. The right ear was normal. In September 1942, a cholesteatoma exposing the lateral sinus and labyrinth was evacuated. Now the healed shell-like tympano-mastoid cavity has a refulgent lining with a bright light reflex from the fenestra ovalis. The operation cavity always keeps beautifully clean, without any special attention. A whisper can be heard in either ear.

Meatal Plastic Earlids : a Suggestion for Comparative Anatomy

Operations for chronic otitis media are unlikely to be successful unless a plastic operation is performed on the external auditory meatus,

Preventive Treatment of Chronic Otitis Media

so as to allow free access to the cavity during the healing period and to prevent the formation of keratoses later. An aperture wide enough to be ideal for these purposes is apt to be unsightly, especially in males, in whom it is not covered by the hair. Particularly after a conservative operation, it does not seem right to leave such delicate structures as the tympanic membrane and ossicles thus exposed; one might expect swimming in cold water to bring on vertigo and nystagmus, though in practice this does not seem to occur.

On turning to comparative anatomy, we shall at least find ourselves in good company; indeed no one should presume to operate upon the human ear without some knowledge of zoology, or without at least a desire for a further insight into this vast subject. The earlids of crocodiles were dissected by Killian, who refers to the writings of Blanville, Huxley and others. Of the elevator of the upper earlid, Killian writes that he is naturally unable to state the extent to which the upper earlid can be elevated, but he doubts, owing to the stiffness and thickness of this operculum whether it could be lifted more than 2-3 mm. For the depressor auriculæ, he postulates a powerful action in closing the upper lid.

My own observations are limited to inspection of crocodiles and alligators in the London Zoo, with the invaluable assistance of Mr. Budd of the Reptiliary, and Mr. Stratton of the Library. The upper earlid was in a closed position and seemed to have no more capacity for movement than the various parts of the human auricle. When the earlid was lifted up, the reptile seemed to have no power to close it to protect the tympanic membrane. The lower ear-lid was capable of more movement, especially anteriorly, where it was more fleshy, resembling the human lower eyelid in power to seal the aperture. In diving trim, the eyeballs are retracted into their sockets, the third eyelid is drawn across the cornea, and the reptile lies in shallow water watching with an unwinking stare and listening. The foot plate of the columella in the fenestra ovalis conveys certain vibrations; others reach the cochlea by bone conduction. The laryngeal sphincter closes to a pinpoint and the interlocking faucial folds close the gullet. A sudden swish of the armoured tail brings a meal within reach of the powerful jaws. Ashore, a livelier aspect is presented, with glittering periscopic eyes protruded, earlids slightly parted and perchance the musk glands, which open beside the angles of the lower jaw, in operation.

• The Hippo also has earlids.

To revert to plastic surgery, inconspicuous earlids which could be raised passively would have certain advantages. Surgical technique cannot be modified too cautiously, but I have succeeded in constructing earlids on the Saurian model in one or two cases. The resemblance is as distinct as that of the cercopithecus or macacus type of human ear to the prototype, but only noticeable on close examination.

Summary

It is estimated that a quarter of a million civilians and soldiers in Britain are partially incapacitated by chronic otitis media. The reasons are briefly set out for regarding infancy as offering the best scope for preventive measures.

That in health the Eustachian tube carries not only air to but also fluid from the ear is sometimes overlooked.

Conservative endaural operations are discussed. An operation of access *viâ* the cavum conchae is described and illustrated. Some 250 cases are briefly reviewed; success seems to depend mainly on the morbid anatomy of the temporal bone, though healing is a complicated process. Two cases are described; in one of these miniature earlids were provided by a simple plastic procedure.

A note on the earlids of alligators concludes the contribution.

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CLINICAL RECORD

TWO CASES OF MALIGNANT DISEASE OF THE TEMPORAL BONE

By LIONEL COLLEDGE (London)

MALIGNANT tumours of the temporal bone are not common, but are usually epitheliomatous in character and have their origin either in the external auditory meatus or the middle ear. The two cases described each present unusual features, but both exhibit the usual extensive spread, particularly in the parotid region, before the dura mater is penetrated, owing to its capacity for insulating the central nervous system.

1. J.W., a female child aged 6, was seen on *May 12th, 1941*. There was no reliable clinical history of the case, but the meatus on the right side was packed with soft granulation tissue and there was a complete facial palsy on the same side, suggesting a possible diagnosis of tuberculosis. A radical operation showed the temporal bone to be soft and widely infiltrated. The wound was left wide open but in the subsequent course showed no tendency towards healing. An indefinite report was received on the nature of the tissue removed, but no evidence of tuberculosis could be found. Progress was unsatisfactory, the granular masses increasing in the cavity, whilst the child wasted, and on *June 10th* an enlarged gland appeared below the mastoid process and increased rapidly in size. Towards the end of this month a large tumour appeared in the nasopharynx and right side of the pharynx. There was also squint and ptosis of the right eyelid. On *June 28th* the patient succumbed to exhaustion and repeated small hæmorrhages from the nasopharynx.

As it had become evident that the disease was not tuberculosis but a rapidly growing malignant tumour, Dr. Carnegie Dickson consented to undertake the post-mortem examination and made the following report.

The body was that of a small, poorly developed, and much emaciated female child, her size suggesting the age of 3 or 4, rather than 6. There was a swelling of the right side of the face, more especially in the parotid region, suggesting a tumour of that gland, spreading, not only into the region of the ear (with a rounded projecting mass presenting through the external auditory meatus), but also, down the neck and over and under the ascending ramus of the lower jaw, and when dissected out, showing large masses spreading into the roof of the nasopharynx, and also through the temporal bone, which was greatly expanded. A nodule of the tumour projected internally into the posterior fossa from the body of the temporal bone, and was about the size of a large bean, compressing the right side of the pons, and evidently causing pressure upon the right third cranial nerve, and the trigeminal, the latter being much compressed and practically destroyed. The VIIth and VIIIth nerves were also compressed by the posterior part of the mass, but their continuity was not destroyed. A small nodule of the tumour projected through the wall of the

Lionel Colledge

tympanic cavity, in front of the foregoing larger mass. The whole tumour was excised, along with the adjacent invaded bone.

No metastases were found in the lungs, liver, spleen, or other internal organs, and the only point of interest found on examination was the presence

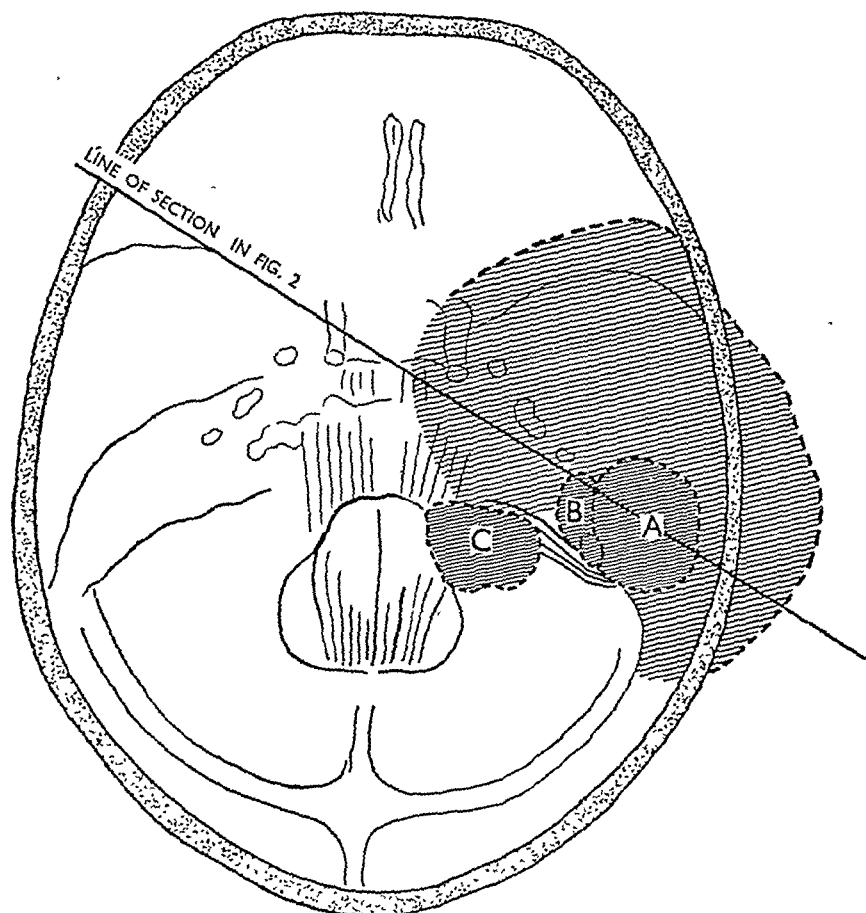


FIG. 1.

Tumour shown by cross hatching. Light cross hatching indicates bone ballooned and bulging. Deep cross hatching indicates tumour at A and B bulging upwards through upper aspect of the temporal bone, but not through the meninges. C indicates a nodule which has perforated the bone and has compressed and distorted the right side of the pons, stippled.

of an ovarian cyst about the size of a cherry in the right ovary, and another, flaccid, thin-walled cyst, probably parovarian, of about the same size, in the broad ligament. The left ovary, on the other side of the small, infantile uterus, appeared normal.

Provisional Summary

Large malignant tumour in the region of the right parotid, invading the surrounding structures very extensively—including the base of the skull, temporal, sphenoidal and ethmoid bones, etc.—with large projecting mass in nasopharynx.

Clinical Record

Microscopical Examination of the Tumour

Sections of the spreading edge show a spindle-celled sarcoma, with cells of medium size, and with a variable amount of formed intercellular material, at

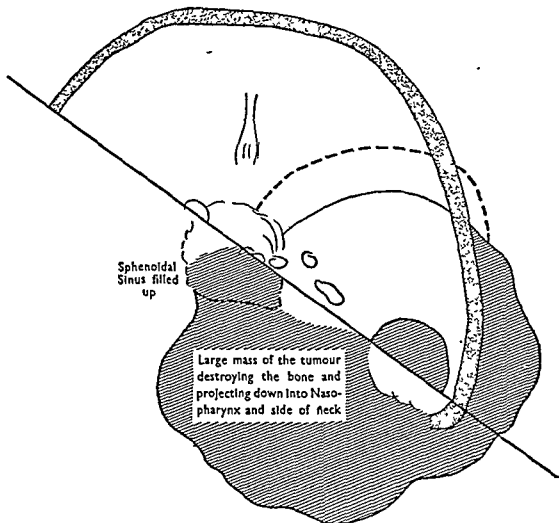


FIG. 2.

Large mass of the tumour destroying the bone and projecting down into nasopharynx and side of neck

some parts moderate to considerable in amount and approaching a "fibrosarcoma" in type, but from these at other parts developing more cellular characters with cells closer together and scanty intercellular material. The vessels are fairly numerous and vary much in size, but all have very imperfect thin walls—the larger spaces thus having the appearance of blood-sinuses.

Several enlarged lymphatic glands from the neck in the immediate neighbourhood of the tumour were examined as their naked eye appearance suggested probable malignant infiltration—but this was *not* found—the change present being simply marked oedematous separation of the cells and general gland structure.

No remains of parotid glandular tissue were found, nor any histological evidence of the origin of the tumour, though its anatomical situation suggests possible origin from the parotid. This, however, owing to the wide infiltration and large size of the mass must remain more or less speculative.

Diagnosis: Spindle-celled sarcoma.

W. E. CARNEGIE DICKSON.

Lionel Colledge

2. F.B., a female aged 38, presented herself on *November 21st, 1940*, for examination of her right ear. She had had a radical mastoid operation performed by Mr. J. Cuning at the Victoria Hospital for Children at the age of 5. The cavity was found to be in good order, dry, well-shaped and perfectly epithelialized.

The patient presented herself again on *May 5th, 1941*, when the cavity was unexpectedly found to be packed with granulations. She was kept under observation and on *June 3rd* complained of severe pain in the ear and side of the head and some swelling was observed in the parotid region. Therefore on *June 6th* the auricle was turned forward and the cavity in the temporal bone explored. It was evidently filled with growth and not simple granulation-tissue, and in the mass of growth an abscess cavity ran upwards between the temporal muscle and the squamous portion of the temporal bone. Drainage of this abscess gave complete relief to the pain, although the tumour continued to grow rapidly in the parotid region as the photographs taken six weeks later show quite clearly. Professor Newcomb described the tumour histologically as a polygonal celled undifferentiated carcinoma invading granulation-tissue.

The only record, which a superficial search of the literature has revealed, of a carcinoma arising in the cavity after a radical mastoid operation, is by Halphen and Djiripoulos. In this case the growth was observed three months after a radical operation for long standing otorrhœa, which had caused a facial palsy and attacks of vertigo two months previously, so that the possibility that it was already present and the cause of the symptoms when the operation was undertaken can hardly be decisively excluded, though so competent an observer as Halphen saw no indication of it at that time, nor for at least two months after. At the same meeting of the Société de Laryngologie des Hôpitaux de Paris, when Halphen's case was exhibited, Sourdille mentioned a similar case with an interval of six months after the operation, and the same comment applies to this. In the case recorded above the interval of 33 years excludes any such possibility.

REFERENCE

HALPHEN AND DJIROPOULOS, *Arch. Intern. de Laryng.*, 1930, ix, 838.



FIG 3



FIG 4



FIG 5

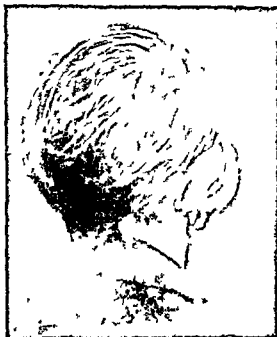


FIG 6

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• SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

Friday, May 7th, 1943

President—V E NEGUS M S

Discussion on Nasal Allergy, Excluding Hay Fever

The opening papers by Dr George Bray Dr Cyril J Polson and Lieut - Colonel Myles Formby appear in this issue of the *Journal of Laryngology and Otology*, pp 219 242

The PRESIDENT said that these opening papers had been most comprehensive Dr Bray had divided those treating nasal allergy into pricklers and "chiselers", and Colonel Formby had fallen into the latter category when he mentioned a fairly drastic form of radium treatment He thought that they should not be separated quite in the way that Dr Bray had suggested, this was a subject in which the allergist must be consulted and play his part, though not to the exclusion of the rhinologists He had himself been fortunate in having to work with pathologists who had attempted to carry out desensitization It was a comprehensive problem and he fully recognized what comments Dr Bray might make on the surgical treatment of these cases There was some reason for regret that many patients had been treated on surgical lines in the first place when certainly attempts should have been made to treat them as a more general problem Dr Bray might have had greater success, but he himself had seen many attempts at desensitization which had failed He had always kept an open mind as to the general treatment, but the condition of a certain number of patients had shown the necessity of some local measures

Dr Bray had spoken rather scornfully of ionization, but at his hospital it had been felt that ionization not only caused zinc ions to form a coagulum but drove hydrogen ions into the tissues themselves

Dr Polson had spoken very clearly about the appearances of the tissues, but what went on in the physiological processes was a problem It made it rather more complicated when one knew that the pH in allergic cases changed towards the alkaline side Apparently the nucleus was rather more alkaline, and the cytoplasm rather more acid than the tissue fluids The changes which took place had been the subject of a great deal of work by Dr Bray, himself and others, and the differences of pH and of ion content seemed to be of great importance A further point was the excretion of carbon dioxide from the nasal mucous membrane which was said to be several times more active than from the alveolar mucous membrane This would rapidly upset the balance between the alkaline and the acid state

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Lieut.-Colonel NORTON CANFIELD (U.S.A.M.C.) said that he had been much interested in Dr. Bray's statement that this subject was simple. He had not found it so. His experience had been with a University Hospital clinic in which there were a large number of these cases appearing in the group known as allergic. Many of them had been operated on a long time previously, with various results. Many were entirely unsatisfactory. About five years ago he took the stand that surgery in these cases should be *strictly limited*. All the cases which came through were referred directly to the allergic clinic first, even those cases in which polyposis seemed to be a common feature.

The result of that work after having been turned over to the allergist was a very slight improvement in most of the cases. Going over a group of these cases—about 150 of them—it was considered that the primary allergic treatment by people who were actually studying allergy was an improvement satisfactory to the patient in only about 5 per cent. The patients were then turned over to the rhinologist and an endeavour was made by various means to relieve them. They were extremely conservative in their surgical approach and in very few of these cases was any actual major sinus surgery done. They simply tried to relieve the congestion inside the nose by removal of the obvious polypoid material, and occasionally they would open the sinuses if severely infected. In some cases the allergist had reported a large number of allergic factors—anything from 6 to 15 different allergens. In those particular cases they had been very unfortunate in giving them relief by any method of treatment.

A question was asked as to the results in cases which had not had any surgery or previous treatment before reference to the allergist.

He had wondered whether Dr. Polson, as a biochemist, could throw any further light on the question as to which came first in these conditions, the infection or the polyp. For his own part he thought the polypoid disease occurred first, and then the nose, because of obstruction, became more susceptible to infection. He recalled that at the meeting of the American Academy of Ophthalmology and Oto-laryngology in October 1943, there was a paper by Dr. Anderson Hilding in which he pointed out a pathological finding in patients who had been subject to asthma, and at that meeting of 2,000 members there was no challenge to the statement that this was possibly a new observation. With the thought in mind that if pathological material from the nose and sinuses could be examined carefully enough, possibly some similar change would be found, he wrote to Dr. Hilding and asked him to send some information. The chief finding which he observed as a result of examining microscopic sections of the bronchi from patients who had died in status asthmaticus was that the bronchial ciliary epithelium was completely metamorphosed into an entirely different kind of cell. Instead of columnar epithelium along the bronchial mucosa, the bronchi in many cases showed a complete change over from the ciliated epithelium to goblet cells, so that there were anywhere from 60 to 100 per cent. of goblet cells. This was also accompanied by the loss of cilia from the surface of the cells, so that movement of mucus along the inside of the airway was made extremely difficult. Experiments showed that thick, sticky tenacious material was much more easily moved by cilia than the thin watery secretions which were found in the nose and throat.

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In the absence of the cilia from the surface of the bronchial cells, many of which had been replaced by goblet cells, there was a tendency to a collection of mucus in the bronchi which was not only in itself obstructive but which could not be moved by the goblet cells. Thus a mass of mucus was anchored in the cells which replaced the normal cells of the tracheal and bronchial mucosa and protruded into the lumen.

He felt that the allergic group of diseases about which they were talking, and which they saw so frequently, were not the manifestation of local disease but of a somatic dyscrasia, the essential and important factors of which were entirely unknown.

Major E. P. FOWLER (U.S.A.M.C.) said that he had had a patient who for three years had unilateral hay-fever symptoms. On one side of the nose there was a thin secretion of mucus, the membrane was oedematous and extremely pale. On the other side it was quite normal. Smears taken from the mucus of the nose showed 90 per cent. eosinophilia on the affected side and a normal condition on the other. The patient had had trouble from the time when a surgeon had removed the stellate ganglion on the affected side. At first her chief complaint was a stuffiness of the nose, but as the years went on she found that any type of irritation, particularly a cold, would produce a copious secretion, and she would be very much worse. She tried various drugs, but anything in her nose made the secretion still more abundant. She had a slight deviation of the septum to the affected side which made it a little worse. He tried the usual things first, and then tried atropine. When she took belladonna by the mouth she was very much better, but she quickly got atropine symptoms, and on advice he gave her syntropan (Roche), which was a synthetic atropine-like drug, and now she took syntropan in winter.

In the summer she was fairly free from trouble without drug therapy. He had found the same drug useful in other patients who had very watery secretions from the nose. He suggested that otolaryngologists should look at every case of Horner's syndrome and see whether cases of unilateral vasomotor rhinitis could be discovered. Two other cases in which the stellate had been interfered with had a history which was very much the same as that of this girl. In one of them ten years before the stellate had been removed for vascular disease, and his chief complaint at the time was a watery nose. Another patient, an old lady, made a complaint of the same symptom after alcohol injection of the stellate ganglion. In his view allergic rhinitis was a manifestation of sympathetic or para-sympathetic imbalance, and it was interesting to find a surgical case which demonstrated this very definitely.

Major GORDON D. HOOPLE (U.S.A.M.C.) said that he agreed with Colonel Canfield. The experience he had had with the allergists had been rather unsatisfactory, or at least not satisfactory enough for him to feel that they should turn over these cases to the allergists and dismiss them from their standpoint. He had come to feel very strongly himself that they as rhinologists must keep these cases in their own hands, realizing at the same time that they were the result of a general disease and that they were looking after the local manifestation.

His own feeling was that the reason for the unsatisfactory improvement under the allergists' treatment was that most of the allergists over-treated

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them. They waited for manifestations of reactions at the site of injection in the skin to show that the patient had reached the maximum dose which could be tolerated and which would create a desensitization, whereas he felt that the reaction could be observed first in many cases in the nose, which came before the skin manifestation appeared.

Major P. E. IRELAND (R.C.A.M.C.) also agreed with Colonel Canfield. There were a good many cases in which the allergist had helped, but he did not like the idea of turning over all cases to him. Some cases seemed to be relieved by ionization. What they finally found useful was nitrate of silver bead in front of the turbinate. He thought they had to distinguish between these cases due to allergy and vasomotor rhinitis. He had treated a great many such cases with simple silver nitrate. This complaint was a discomfort, but not a disability. One of the openers had mentioned the adverse effects of central heating. In his own view in this country it was rather the lack of central heating which might have the ill effect, especially amongst the Canadians now living here.

F. A. PICKWORTH, Birmingham, said he was often asked to distinguish between allergic and inflammatory tissues taken in a quiescent period. He showed colour photographs of *eosinophils* in bone, conjunctiva, and nasal sinus membrane. They were to be seen wandering through intact epithelium to collect in extruded mucus. This wandering into non-living tissue pointed to a chemotactic attraction of eosinophils from the blood to dying tissue: produced by antigen-antibody reactions which caused tissue coagulations, lymphatic obstruction, and other vascular changes. He had found large numbers of *extruded eosinophil granules* in such early degenerating areas and layers, these were associated with collagen formation (a stage towards fibrosis). Some of the granules might become basophilic and were a hindrance to the search for gram-negative organisms. Other Kodachrome slides showed these eosinophil granules, and tissue changes of exfoliated epithelium, microscopic ulcers, round cell infiltrations, excess of polymorphs in the venules, and deposits of iron indicating recent but not operative extravasations of blood, in quiescent but allergic membranes.

CLEMENT FRANCIS said that account must be taken of the general condition of the patients. It was difficult to do any good to patients with vasomotor rhinitis if they were overworked and run down, or if they had been subject to a long period of worry and anxiety. In nasal treatment any operation which damaged or removed the nasal mucous membrane made the patient worse. The most valuable surgical measure was submucous resection, and this might be undertaken if there was a marked deflection, but not otherwise.

In cauterizing the nose, if a fine cautery point were used and a very light application made, it would be found that there was an effect not only on the nose but on the vasomotor tone of the body as a whole. For example, the feet of the patient would become warmer. His own routine treatment was to apply the cautery to the septum, first on the one side and then a week later on the other, and if the symptoms subsided nothing more need be done. If there was a recurrence of symptoms one should look for a hypersensitive area on the inferior or middle turbinate. Combined with nasal treatment, any treatment which would improve the circulation would help the vasomotor

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rhinitis Even to rub the back of the neck and the scalp would remove the congestion of the nose Any exercises which improved the circulation would relieve the vasomotor rhinitis It was quite a common experience for tennis players when they became warm and their circulation was in proper order to find that some existing nasal congestion was relieved One point to remember was that the patients should get their circulation going before they got out of bed If they did a few exercises and rubbed their scalp, then, when they got out of bed and put their feet on the cold floor, they would not have the symptoms of allergic rhinitis

He had never found any benefit from local applications of sprays or drops Adrenalin would confer a temporary benefit, but there was a compensatory vasodilatation and the condition became worse Moreover adrenalin inhibited ciliary action Any operation on the nose and throat would temporarily benefit the allergic rhinitis, partly owing to the psychological effect and partly to the effect of hæmorrhage, and a sinus operation might even give the patient relief for a month Unless the case was carefully followed up, however, a false value might be given to the results of the operation He had been interested in what Colonel Canfield had said about the destruction of cilia in allergic cases He had noticed very many disastrous results both in allergic rhinitis and in allergic asthma from the continued use of inhalants containing adrenalin The use of powerful inhalants made the condition permanently worse

L MUSGRAVE WOODMAN said that he had had a considerable amount of help from Dr Bray, but he thought that two methods had not been sufficiently mentioned, one of them being the old process of cauterization, with which he had had good results and the other zinc ionization, which was not a cure for all cases Nevertheless many came back year after year after a summer perfectly free from hay fever and any other trouble He was sure that Colonel Formby would forgive him if he criticized the radium treatment They were all agreed that the less they did in the way of surgery the better A large amount of surgery was being done for what was largely a medical condition As to radium, Colonel Formby was putting in a fairly large dose for a very short time, but it was well known that when applying radium to day they were using smaller doses for a longer period of time He deprecated any departure from the proper use of radium

The question of sepsis altogether was a very interesting one in relation to allergy, and he was quite certain that these allergic patients were very much more easily infected than normal patients If an operation was done at all they had to take many more surgical precautions and in his judgment it was absolutely fatal to do any operation during the acute stage He never touched a patient during that period

The last point he wished to make was with regard to the psychology This was very important, and in this connection he mentioned the use of breathing exercises He had had some extraordinary results by first obtaining the patient's co operation and then following this up with breathing exercises by an established routine

VERA WALKER asked whether Dr Bray considered that the protein metabolism of the body might play some part in this allergic disease Her own

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attention was drawn to this matter by cases of apparent allergic rhinitis coming to her, especially associated with some œdema of the eyelids or lips. In an attempt to explain why this spontaneous allergy had occurred in these patients—for in 27 out of 30 cases there was no previous history of allergic manifestation whatever—she had gone into the question of diet with them. They were all adults and one article of food of which they were short was eggs, the natural source of riboflavine in a normal diet. They had also very little milk. She put these people on to 2 mgr. of riboflavine three times a day for three or four weeks before starting any further anti-allergic treatment. Out of the 27, 12 refused to have any injections at all, they were all better and they had had no recurrence. She went on to speak of the endocrine relationship to allergy. For some time it had been suspected that an acute rhinitis showed that something had upset the water balance in the body. Two acute cases had been brought to her recently, both of them dispensers. The trouble had occurred in the hospital where a special cocaine paste was used together with ground-up suprarenal gland, and when handling this ground-up gland these people developed symptoms to such an extent that they had to be put to bed. The first one had acute rhinitis and felt very weak. The second case did not report at once, but was brought back next day with a gingivitis as the main symptom, together with rhinitis and a later development of iritis. Other cases were followed up, but these two only out of the seven who had handled the material, suffered in this way. When she tried to make a skin test with the ground-up gland, as soon as the box was opened, streaming or pouring water from the nose occurred in these patients.

GEORGE BRAY, in reply, said that the only cure which he had heard that day, apart from desensitization, was pregnancy. With regard to desensitization it was usual for cases to react to several allergens. Patients were asked to avoid as much as possible the allergens to which they were sensitive, but in *the case of the more common allergens the procedure was to desensitize with the main things to which they reacted.* There was a good deal of difference between desensitization as carried out now and as it used to be. Nowadays concentrated solutions of those allergens to which the patient reacted are used, and adrenaline is added to the solution to prevent an immediate reaction, and the solution was given several times a day, so that with a more concentrated and rapid course of injections the majority of these cases tended to improve. While the allergic person was sensitive to some specific substance, when he was in a good state of health he was producing adrenaline in his body which counteracted it, but when he had a cold or influenza or was subject to worry, he used up his own adrenaline supply.

Bacterial infection played no specific part in the allergic condition. Infection in the nose was usually the result of interference.

With regard to the question put by our American friends about desensitization, he would mention that in this country much stronger solutions were used, and their results were very good. The majority of cases which were marked by sneezing in the early morning could be relieved without touching the nose. In other cases, if associated with hay fever and complications, the matter was more difficult, but the most difficult cases of all were those which had had ionization and cauterization and various other surgical procedures.

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The large majority of these attacks came from air-borne inhalants such as those he had mentioned in his paper, feathers and down, orris root, animal emanations, dusts, insecticides, fungi, osmyls, or odours. A large number of papers had been written with regard to the effect of vitamins B and C, but no definite reports of beneficial actions had been forthcoming, at all events relating to a long series of cases over a long period. Someone had mentioned the shortage of sugar in these people, but if a patient was having a lot of adrenaline the sugar content of the liver was lowered, and it was characteristic of the asthmatic or hay-fever case, that they were constantly producing adrenaline to protect themselves and so burning up their sugar.

C. J. POLSON, also in reply, said that he was tempted in the light of the discussion to desert his own field and enter into the field of treatment, but he would refrain. On the subject of gastric analysis he must be allowed, for the present, to agree to differ from Dr. Bray. He also believed that œdema was was a real phase, though whether inflammatory or allergic or not had yet to be shown. He was inclined to agree with Colonel Canfield that infection in the polypi was a secondary and not a primary manifestation. He did not agree that nasal polypus was a dead structure; the epithelium seemed to him to be quite living.

Colonel MYLES FORMBY, also in reply, addressed himself to the question of ionization. A few years ago he had access to some sections showing the effects of ionizing the nose in rabbits, and the sections showed definitely the complete destruction of the ciliated epithelium, which was replaced later on by a more flattened epithelium, but the most striking change of all was a subepithelial fibrosis.

Mr. Francis had mentioned the part played by the circulation. That was a very important feature. He once came across an enthusiastic masseur who said that he could cure nasal polypi by massage. In point of fact the patient demonstrated had no nasal polypi but he had got very œdematous turbinates. The masseur manipulated the man's neck, and certainly at the end his turbinates had considerably reduced in size and he was able to breathe through his nose as he was not able to do before.

As for Mr. Musgrave Woodman's criticisms of his use of radium, he would point out that all the cases in which it was used were desperate ones. He knew that it was a drastic dose to give and it was used for the purpose of irradiating a very limited area, giving it a good dose for a short time. He was treating only a symptom, but a desperate symptom. It was far from his purpose to lead any of them to believe that any of these patients were outpatients. None of them were in hospital for less than a week, many of them for a fortnight. There was no question at all that irradiation did damage the cilia.

On the question of infection, these people, once they were interfered with surgically, were probably infected, for the reason that the normal protective mechanism of the epithelium was not as good as it should be owing to the deprivation of cilia.

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OSTEOCLASTOMA OF THE TEMPORAL BONE

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OSTEOCLASTOMA of the temporal bone is a very rare disease. We have found only two well-authenticated examples in the literature, namely those of Döderlein (1913) and Ramadier and Tournay (1937), and two doubtful cases, reported by Lutz (1900) and Nicolai (1912). Indeed the skull as a whole, apart from the jaws, is seldom affected by this tumour. Geschickter and Copeland (1936), in their analysis of the records of the surgical pathological laboratory of the Johns Hopkins Hospital for 35 years, found 136 cases of typical benign giant-cell tumour of bone. Of these, 22 occurred in the skull, namely 14 in the mandible, 6 in the maxilla and 2 only in the rest of the skull, both of them in the sphenoid. Other recorded sites in the skull are the frontal bone (Fraser, 1931; Mathers and Cappell, 1938), septum nasi (Wieder, 1932), ethmoid labyrinth (Wattles, 1937) and hard palate (Ballou, 1941).

We have recently had the opportunity of investigating, both during life and after death, a remarkably fine example of osteoclastoma originating in the right temporal bone.

Review of the Literature

Döderlein (1913) described a case which is of particular importance because it was possible to demonstrate with considerable precision the site of origin of the tumour within the petrous portion of the temporal bone and also on account of the close correlation of clinical symptoms and anatomical findings. The patient, a female aged 37, was seen in August 1911, complaining of pain and deafness in the right ear. Three months later severe vertigo developed. In March 1912, examination showed

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narrowing of the external auditory meatus due to collapse of its upper wall. At operation the mastoid air cells were normal, but the antrum was small and the greater part of its posterior wall was missing, the aperture here leading into a cavity, apparently within the labyrinth, which was lined with tumour tissue. Some of this tissue was removed and proved to be "giant cell sarcoma" microscopically. Döderlein's Fig. 2 shows the structure to be typically osteoclastomatous (benign giant-cell tumour). The patient died a month later. *Post mortem* there was great flattening of the cerebral convolutions. The anterior pole of the right temporal lobe was firmly adherent to the dura and on pulling away the brain an abscess the size of a hen's egg was disclosed, with oedema of the surrounding brain tissue. The underlying bone was replaced, over an area of 3 cm., by a greyish-brown mass of tumour tissue. There were no metastases. On serial section of the excised right petrous bone, the pyramidal portion was found to be largely destroyed by growth, whose histological characters were those of "giant-cell sarcoma". It was possible to demonstrate the exact relation of the tumour to the internal and middle ear. Sections at the level of the foramen ovale showed that the tumour had invaded the middle spiral of the cupola cochlearis, largely destroying both the bony lamina spiralis and the membranous portion and almost filling the lumen (Döderlein's Fig. 1). The basal and apical spirals, however, were free from growth.

Ramadier and Tournay (1937) reported the case of an adult female in whom clinical diagnosis was possible at an early stage, permitting successful treatment by curettage and X-rays. The first symptom was right neuralgic hemicrania, radiating to the neck and right shoulder, and followed by intermittent vertigo and violent tinnitus in the right ear. Two months later the patient developed right facial palsy and became deaf (presently completely deaf) in the right ear, and vomiting supervened. Otological examination after some months showed complete right cochleo-vestibular paralysis (absolute aerial deafness, Weber test to left side, total non-excitability of the vestibule to the temperature test) and complete VIIth and VIIIth nerve paralysis. Occipital craniotomy was carried out on a diagnosis of ponto-cerebellar angle tumour, but no lesion of cerebellum, crus cerebri or related cranial nerves was discovered. There was, however, obvious softening of the posterior wall of the petrous bone in the region of the internal auditory meatus. Two months later a second operation was carried out. The petrous and mastoid portions of the temporal bone were explored, but nothing was found until, in the petrous bone near the anterior extremity of the attic and just above the genu of the facial nerve, a nodule of soft, red, bloody tissue was exposed and curetted. Examination of this fragment showed that it had eroded part of the superior semicircular canal. Histological examination at the Radium Institute, Paris, proved it to be a "sarcome à myélopaxes".

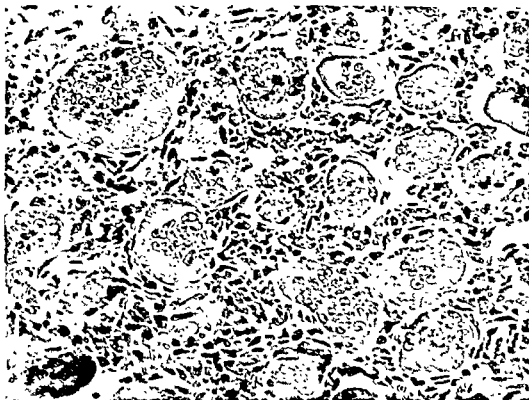


FIG. 1.

Osteoclastomatous aural polypus The clear-cut distinction between the osteoclast-like giant cells with their many small centrally situated nuclei, and the polymorphous cells of the matrix with their larger, more deeply staining nuclei is well seen. Numerous red blood corpuscles lie free in the stroma $\times 250$.

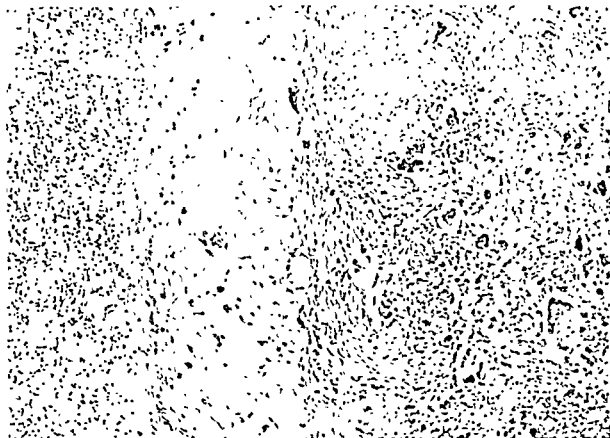


FIG. 2.

Osteoclastoma invading cerebellum. The tumour, which occupies the right half of the field, shows a very fibrous matrix with osteoclast-like giant cells in small numbers. The pale zone to the left of the tumour is the shrunken and atrophic outer (molecular) layer of the cerebellar cortex; to the left of this again is the granular layer, also atrophic, and showing a great reduction in the number of nuclei. The tumour tissue is in immediate contact with the cortex of the cerebellum, without intervening meninges. There are no Purkinje cells between the granular and molecular layers $\times 100$.

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Radio-therapy over some months led to disappearance of all symptoms except the facial and cochleo-vestibular paralysis ; otherwise she appeared to be cured. X-ray examination between the first and second operations showed a virtual " amputation " of the inner half to two-thirds of the petrous pyramid. Pictures taken after the second operation showed much eburnated dense bone replacing the clear area of decalcification (" cure by recalcification ").

The case reported by Lutz (1900) was that of a boy aged $9\frac{1}{2}$ years who had been treated by his doctor for about 6 weeks for pain in the left ear with discharge of thick, foul-smelling pus. A " granulation tissue polyp " had been removed with the curette and another now presented itself. Thorough removal under cocaine was again followed by recurrence. The mastoid was now explored and its interior found to be occupied by a foul-smelling mass of granulations and pus. All this was cleared away but once more there was recurrence, and death ensued some three months after the first operation. Microscopically the excised tissue was stated to show " a small round-cell sarcomatous formation with a number of giant cells ". There is no illustration and the course of the disease would suggest a frankly malignant type of sarcoma.

Nicolai (1912) reported a case of primary sarcoma of the middle ear in a male aged 19. One month after the first onset of symptoms (severe left-sided neuralgia, deafness and facial paralysis) the tympanic membrane was incised and a portion of the tumour removed. It was described as a sarcoma with giant cells, richly vascularized, with extensive necrotic change and hæmorrhagic and leucocytic infiltration, but there are no histological details and no figures. The patient died one month later but there is no post-mortem report.

Case Report

Clinical History. Mrs. F., aged 50 years, had no aural symptoms until March 1939, when she complained of tinnitus in the right ear. In June she began to be unsteady on walking and was admitted to the General Infirmary at Leeds under the care of Mr. W. M. Munby. On July 5th a polyp was removed from the right ear, but it was not submitted to histological examination. There was no further vertigo, but in the following month she was seen in the out-patient department, when the polyp was found to have recurred. She was to have been admitted for further treatment, but the outbreak of war intervened and she was next seen by one of us in the out-patient department on May 30th, 1940. She still had a polyp occupying the right auditory meatus. It was red, with a slightly rough surface, and appeared to be coming from the middle ear. There was no otorrhœa, but she was deaf in the right ear, the conversational voice being heard at a distance of only one foot. In addition there was a smooth firm swelling in the right pre- and infra-auricular region of two months' duration. It was about an inch in diameter and projected about a quarter of an inch. There was no facial palsy. The polyp was removed and examined microscopically. It had the typical characters of osteoclastoma.

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A radiological examination was made by Dr. A. S. Johnstone on June 6th, 1940. The lateral mastoid film showed an area of bone destruction involving the right mastoid process and extending posteriorly to the occipital bone, with a small upward extension into the squamous temporal. The external auditory canal was eroded and several sequestra were seen. The oblique and basal films showed that the destruction had extended widely into the petrous temporal and adjacent occipital bone, obliterating the groove of the sigmoid sinus and approaching the foramen magnum. There were no changes indicative of an inflammatory reaction. The appearances were those of a neoplasm, probably arising in the mastoid.

In consultation with Mr. G. W. Blomfield it was decided to explore the mastoid process, and this was done by Mr. Munby on June 19th, 1940. The cortex of the mastoid process was removed, when the whole of the interior was found to be occupied by soft red vascular tumour tissue. This had eroded through the anterior part of the tip of the mastoid and was continuous with the external swelling in front of the ear. The outer part of the bony auditory meatus was infiltrated by growth which extended medially into the facial ridge. The whole of the middle ear was filled with tumour tissue, no ossicles were seen and there was considerable infiltration of the internal ear. In no direction was the limit of the tumour reached and bleeding was considerable. A large portion of the mass was excised, but it was considered impossible to remove the whole of the lesion. Accordingly a 6.6 mg. radium needle in a rubber tube was inserted into the mastoid cavity and left *in situ* for ninety-six hours. Facial palsy followed the operation, but apart from a rise of temperature on the second and third days the post-operative general condition was satisfactory. Microscopic examination of the tissue removed confirmed the diagnosis of osteoclastoma.

On July 24th the radical operation was completed by cutting a meatal flap, while the mastoid incision was sutured. Dressings were carried out through the meatus and the patient was discharged on August 16th. A week later the mastoid cavity was satisfactory and was epithelialized except for a small part posteriorly. There was a fistula in the middle of the mastoid incision but this appeared to be closing. The pre-auricular swelling remained as before.

She next reported a month later, stating that she had been confined to bed with high blood pressure. The pre-auricular swelling was said to have become very large but had now decreased in size. The mastoid cavity was satisfactory and the incision had healed, but the pre-auricular swelling was larger than before, being now nearly as large as a tennis ball. It was soft, and almost fluctuant in its posterior part. In view of this development, radiation therapy was resumed and between October 3rd and November 22nd she received 2,700 r units from the radium beam, followed by 1,000 r units of deep X-rays. When next seen on December 5th she had considerably improved and there was a marked reduction in the size of the pre-auricular tumour, which now formed an indurated mass over the posterior part of the parotid region and below the mastoid process. The mastoid cavity was dry and the wound had healed. This improved state was maintained and the general health remained good, though the facial palsy persisted. The external tumour remained as an indurated swelling of the pre-auricular and infra-mastoid regions. She was

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last reported (August 1941) to be making satisfactory progress. There had been a loss of only six pounds in weight since the onset of the illness.

On October 21st, 1941, she again attended the out-patient department, stating that she was not feeling well and complaining of a lump in the throat which was causing dysphagia. There was an indurated swelling over the mastoid process and a large fleshy polyp was projecting from the auditory meatus. The dysphagia was due to a large soft swelling in the right lateral nasopharyngeal wall which had pushed the right tonsil and soft palate medially. Anterior rhinoscopy revealed no abnormality, examination of the post-nasal space confirmed the presence of a swelling in the nasopharynx. There was no epistaxis, and no evidence of ulceration of the nasopharyngeal mucosa. Radiological examination showed a few sequestra. Part of the posterior margin of the tumour was well defined and the growth here appeared to be inactive, but at the inferior margin and in the squamous temporal there was evidence of definite extension. Because of this further activity deep X-ray therapy was resumed once more and during the next six weeks she received 1,200 r units. Owing to failing health, she was unable to attend for further treatment and she was not seen again until April 1942, when it was apparent that her general condition had greatly deteriorated. She had lost two stone in weight since October 1941, and the palatal swelling had increased in size and was now causing trismus as well as dysphagia. Both the meatal recurrence and the pre-auricular swelling were larger, the mastoid wound was ulcerated and there was induration over the mastoid process. She was confined to bed and whilst in no pain she gradually went downhill during the ensuing three weeks and died on May 7th, 1942.

Post mortem Examination, May 8th, 1942 The body was extremely emaciated. There was an area of ulceration above and behind the right pinna, with a small central sinus exuding pus. Below the ulcerated area there was a soft purplish swelling 3 x 2 cm in diameter, while a nodule of similar appearance projected from the external auditory meatus.

The immediate cause of death was advanced confluent bronchopneumonia of the left lower lobe, which was almost completely consolidated, with a similar but earlier lesion of the right lower lobe. The gall bladder contained a solitary cholesterol gallstone 1.5 cm in long diameter. There were two adrenal rests at the outer pole of the right ovary, both showing yellow outer and dark brown inner zones of cortex. There was no evidence of parathyroid adenomata or hyperplasia.

The petrous and mastoid portions of the right temporal bone were almost completely replaced by typical osteoclastomatous tissue, which showed on section an irregular blending of dark maroon and brownish-yellow areas. In the case of the petrous portion, only a thinned out delicate shell of bone remained, which gave characteristic egg-shell cracking. From the tip and anterior portion of the petrous bone the growth had extended inwards and forwards to occupy a large part of the sphenoid and the ethmoids, replacing most of the bony walls of the sella turcica, while polypoidal purple nodules of tumour tissue sprouted into the ethmoid sinuses. From here, a sausage shaped mass of tumour tissue extended downwards immediately external to the right postero lateral wall of the nasopharynx as far as the tonsil. There was much narrowing of the nasopharynx in consequence and the tonsil was flattened out.

to about 2-3 cm. in thickness. The pituitary was almost completely embedded in growth. From the posterior aspect of the petrous bone the tumour had grossly invaded the posterior fossa of the base of the skull, extensively breaching the dura mater and invading the anterior marginal region of the right cerebellar hemisphere, to which it was firmly adherent. It extended as far as the ponto-cerebellar angle and was compressing the pons. On section the cerebellum was found to be penetrated to a depth of about 1 cm. On the deep aspect of the tumour, within the cerebellum, there was an ovoid cyst 1.6×1.2 cm. in diameter as seen on transverse vertical section, with a thick fibrous wall and containing gelatinous material in the fixed specimen. The sigmoid portion of the right lateral sinus was also invaded.

From the mastoid process the tumour had grown outwards beneath the skin, forming a mass 8-9 cm. in vertical diameter and about 5 cm. transversely. The growth was adherent to the angle of the mandible.

Histology

1. The microscopic structure of the aural polypus removed on May 30th, 1940, is that of classical osteoclastoma. Osteoclast-like giant cells are present in the greatest profusion (Fig. 1), occupying in some fields a greater proportion of the total area than the intervening polymorphous-cell tissue. They present the usual variation in size, shape and number of nuclei. The latter are uniformly small, rounded or polygonal and well stained. The rounder nuclei have a well-defined nuclear membrane and vesicular nucleoplasm; the polygonal nuclei present a shrunken appearance and stain more deeply, while the cells which contain them have rather pinker cytoplasm than the other and presumably younger cells. *Cytoplasmic vacuolation is prominent in some of the giant cells.* Several of the larger vacuoles, each measuring up to 20μ in diameter, contain cellular inclusions. The intervening tissue is composed mainly of spindle cells, with a variable proportion of ovoid, spheroidal and polymorphous cells and a minimal amount of collagenous fibrillary material. Much blood is present in the stroma, not all of it obviously within vessels, though thin-walled vessels are certainly abundant. Further evidence of extravasation is provided by the abundance of phagocytosed hæmatogenous pigment. There is no clear evidence of transition forms between the giant cells and the cells of the matrix. Sometimes giant cells are seen lying loose in blood lakes, not necessarily intravascular. In other instances they quite clearly lie external to the walls of thin capillary channels. Mitotic figures may be present but are not conspicuous and the appearances are doubtful. Nowhere is there any suggestion of undue activity pointing to malignant change.

2. The portion of tumour removed on June 19th, 1940, presents the same histological characters as those of the aural polypus, except for a number of small bony spicula embedded in the tumour tissue, with or without a surrounding zone of fibrous tissue. The spicula, which are

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present at a few points only, suggest a reactive change in surviving bony tissue and not the laying down of bone by the tumour itself. Osteoblasts are present in profusion in these spicula. Lime salts are present in minimal amount.

3 The structure of the tumour obtained at autopsy is still typically osteoclastomatous, but there is considerable variation in different parts. In some fields typical osteoclast-like giant cells are almost as abundant as in the aural polypus. Elsewhere they are few. The invasion of the lateral pole of the cerebellum is very striking (Fig 2). The tumour tissue, including abundant giant cells, abuts on the actual cerebellar tissue. Over a considerable area there is even no recognizable intervening pia-arachnoid. The nervous tissue is profoundly changed, the molecular layer of the cortex being reduced in width and intensely vacuolated, while hæmosiderin containing phagocytes are present in large numbers and considerable recent hæmorrhage is present in the inner part. The granular layer presents a more normal appearance, but the Purkinje cells have disappeared over considerable stretches. Even here, where the evidences of invasion and tissue destruction are so striking—the dura mater, for example, has obviously been extensively breached—the structure of the growth remains osteoclastomatous and typical giant cells are seen in direct contact with the nervous tissue. In some fields, however, no giant cells are seen, and the tissue consists of rather loose spindle-cell tissue with considerable uniformity in structure and no mitotic figures.

In the basisphenoid, which has been more or less completely replaced by growth, the tumour is again typically osteoclastomatous, although again giant cells are rather fewer than in the aural polypus. The capsule of the pituitary has not been breached by the growth and the gland itself shows no obvious pathological change. All three cell types in the pars anterior are well preserved. The whole gland is exceedingly vascular, especially the anterior lobe.

The para-pharyngeal growth has a more richly cellular stroma than any of the other portions examined, although typical giant cells are still present in profusion. The tumour here comes into intimate relation with the deep aspect of the flattened out right tonsil, being in direct contact with the base of one of the crypts. There is also a point of contact with the muscular wall of the pharynx nearby, but for the most part the growth is enclosed in a dense fibrous capsule. The sigmoid portion of the right lateral sinus has been grossly invaded by the tumour, which lines part of the lumen.

Commentary

It would seem that despite its unusual situation this histologically typical osteoclastoma bred true to form. The duration of symptoms was apparently little more than three years, but the tumour may well have

been in existence longer than this. Its slow but inexorable progress, with much bony absorption, and its locally invasive and destructive effects on surrounding structures are in keeping with what we already know of the behaviour of this growth. An interesting clinical feature was the formation, at an early stage, of an aural polypus, apparently coming from the middle ear. This was removed, but not examined microscopically. Nearly eleven months later a second (recurrent) polypus was removed and shown to be osteoclastomatous. At autopsy similar polyps were found projecting into the interior of the ethmoidal sinuses. The naked-eye resemblance of these polypi to myeloid epulis was obvious.

Partial surgical removal and radiation therapy seemed to keep the disease in check for nearly two years. Increasing dysphagia and nasopharyngeal obstruction as a result of local extension of the tumour ultimately led to great deterioration in general health, emaciation became extreme and death resulted from bronchopneumonia three years and two months after the first onset of symptoms.

Pathologically the true nature of the tumour was first established by histological examination of the second (recurrent) aural polypus two years before death. The diagnosis was confirmed three weeks later on tissue removed from the interior of the mastoid. Neither then nor in the extensive histological study carried out *post mortem* was there any suggestion of change in the direction of increased malignancy. A remarkable feature was the perforation of the dura mater of the posterior cranial fossa and direct invasion of the cerebellum on a broad front. Yet even here the tumour remained a typical osteoclastoma (benign giant cell tumour : myeloid sarcoma of Paget : tumeur à myélopaxes).

Summary

A case of osteoclastoma of the temporal bone in a woman of 50 is reported, with a clinical duration of just over three years. The histological diagnosis was made two years before death by examination of a recurrent aural polypus. Treatment by partial excision and radiation appeared to give good results for a time. *Post mortem* the tumour was found to have extended widely in the base of the skull and had invaded the cerebellum after breaching the dura mater, but there was no change in histological type and no evidence of metastasis.

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"if a little vein appears between the eyes and the nose of a woman, they say that it signifies virginity and in a man subtilty of understanding, and if it appear great and black, it signifieth corruption, heat and melancholy in women and in man rudeness and default of wit". On the other hand, a vein across the nose is supposed to indicate a short life or that you will be drowned (Bergen, 36). Other groundless beliefs connected with the nose are that the children born in the seventh month of pregnancy often have their nostrils imperforate (Pliny, XI, 59) and that in India swelling of the nose is the result of perjury, theft or falsehood (Lean, ii, 288).

A popular belief in a close relation between the size of the nose and the sexual organs dates back to ancient times, as is shown by the well-known line: "*Noscitur a naso quanta sit hasta viri*", as well as by the modern low catch-phrase mentioned by Partridge, "A long nose is a lady's liking". Havelock Ellis attributes the former line to Ovid, but I have been unable to trace it back further than the Salernitan Collection which also contains the following line: "*Ad formam nasi diagnosticur hasta priapi*" (Kassel).

In an article entitled "The Physiological and pathological relations between the nose and the sexual apparatus of man", Dr. J. N. Mackenzie, Professor of Laryngology and Rhinology at Johns Hopkins Medical School and Laryngologist to the Johns Hopkins Hospital, gives an excellent survey of the early literature of the subject in which he makes special mention of Heliogabalus, the homosexual Roman Emperor who only admitted those who were *nasali* to be his accomplices, and Joanna, Queen of Naples, who selected men with large noses as her friends. A correspondence of the two organs, however, did not always hold good, and cases of bitter disappointment occasionally ensued. The folk-lore connection between the nose and the genitalia seemed at first to be confirmed in the end of the last century by the work of Fliess and others, who under the title of reflex neuroses recorded a number of cases of uterine trouble which had been cured by treatment of abnormal conditions of the nose. It now appears that the supposed connection between the two organs in both sexes has been greatly exaggerated.

In my paper on "Otology and Folk-Lore" in this *Journal* (1942) I alluded to the ancient custom among West African tribes of boring the ears of children whose elder brothers and sisters had died. A similar practice, according to Sir James Frazer (1918, 179 *et seq.*) is carried out in India by the Hindoo parents who bore the right half of the nose of children whose elder brothers and sisters have died. A nose ring is then inserted so that the child may be mistaken by the Evil Spirits for a girl who is therefore regarded as not worth taking.

The folk-lore connected with sneezing is extremely abundant and dates back to remote ages. In classical antiquity, as well as in the Bible

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(2 Kings iv 35) for example, the act is mentioned in Homer (Od XVII, 541), the Greek Anthology (III, 268), Xenophon (Anabasis, III, 2, 9) and Petronius Arbiter (98). In many countries it is still the custom, as Kanner among others has recently shown, to exclaim "God bless you" or its foreign equivalents, such as "A votre Sante", "Gott hilf dir" or "Alla salute", when someone is heard to sneeze. Sneezing was particularly regarded as a good prognostic sign in severe illness, as it was supposed to expel the demon of disease from the body (Hovorka and Kronfeld, II, 4).

Other beliefs connected with this act are that sneezing early on Saturday indicates that the sneezer will not be able to carry out the work he has undertaken and that if the sneeze is suppressed he will be led by his nose (*Id* 1b). Further details connected with the folk-lore of the nose will be found in Kanner's interesting articles.

The following beliefs are peculiar to epistaxis. Its occurrence indicates that you are in love (Lean, II, 258), one drop of blood from the nose commonly foretells death or a very severe illness, while three drops are still more ominous (Brand, III, 17), three drops of blood from a lover's nose indicates the end of love or the death of a parent (Bonnerjea, 183), if a man's nose bleeds one drop from the left nostril only it is a sign of good luck (Melton, quoted by Brewer, 787).

Prophylaxis

In accordance with the general rule in medical folk-lore which I have illustrated in my two previous papers in this *Journal*, preventive measures are remarkably scanty in the folk-lore of rhinology. The following methods are recommended in the case of epistaxis: "To prevent bleeding of the nose drink whey largely every morning and eat much raisin, or dissolve two sumples of nitre in half a pint of water and take a teacup full every hour" (Wesley, 21-2). According to Black (III) writing in 1883, people are told to this day that nose bleeding can be prevented by wearing a skein of scarlet silk thread with nine knots down the front. In the case of a man the skein is applied and the knots are tied by a woman and if the patient is a woman, the knots are tied by a man.

In the case of a cold, Liszt (Hovorka and Kronfeld, II, 6) states that Hungarian peasants wear a piece of sealing wax round their neck as a preventive measure, while in Bavaria, according to Lammert (I 5) inhalation of fresh water every morning is regarded as a means of protection against a cold.

Treatment

This may be considered, as in my previous papers on medical folk-lore, under the headings of remedies of human origin: animal remedies, plant remedies, mineral remedies, hydrotherapy, transfer, charms, patron saints and miscellaneous remedies.

As will be seen, the principal nasal condition for which folk-lore treatment is required is epistaxis.

Remedies of human origin. The patient's own blood is used in the following ways: According to Lupton (i, 66) "you shall stay the bleeding of the nose if you write with the same blood on the forehead of the party that bleeds these words *consummatum est*. A thing proved with many". Moncrief (222) states that "one's own blood fried and snuffed stops bleeding at the nose". In Liepe in the German island of Usedom, if any one have bleeding from the nose let him write his name with his blood on a rag and place it before his eyes and the blood is stopped (Hovorka and Kronfeld, i, 82). Black (97) quotes Floyer to the effect that moss off a man's skull is much used for stopping hæmorrhage from the nose.

In Western Bohemia the following remedies of human origin are employed for a cold: inhale a child's warm urine, smear a coin with the patient's nasal mucus, place it in the road where it will be picked up by a passer-by and invoke the Trinity (Hovorka and Kronfeld, ii, 6)—an example of the combination of a human remedy with transfer.

Animal remedies. The following is an alphabetical list of the animals supplying remedies for epistaxis: ass (dung), mountain buck (liver), carp (stone in head), cock (brain blood), cow (dung), dog (dung), dove (blood), frog (ashes), goat (blood), goose (grease), hen (egg), horse (dung), lamb (rennet), pig (ashes of feet, dung), rabbit (head), sheep (suet), slug (applied to head), spider (cobweb); toad (powder, amulet). Special mention may be made of the following absurd remedy for ozæna which was recommended by Marcellus (X, 60). If the patient is a man he should kiss the nostrils of a he mule, and if the patient is a woman she should kiss the nostrils of a she mule. According to Hovorka and Kronfeld (ii, 469) coprotherapy is used by the Czechs in the form of a plaster consisting of asses' dung, camphor and plantain or an inhalation of the steam from a heated onion in pigs' dung, while in Galicia cows' dung is often used. Roasted horse dung or black dogs' excrement made into a powder and blown into the nose is employed by the Maya Indian herb doctors (Steggerda and Korsch, 69). The animal remedy was most frequently given by inhalation, plugging the nostrils with it, or by mouth, but was also administered in a plaster or worn as an amulet.

Plant remedies for epistaxis are also numerous, as the following list shows: achillea, amaranth, bdellium, cinquefoil, clymenes, clary, hellebore, hemlock, knot-grass, leek, marjoram, mint, moss, nettle, parsley, peony, plantain, rue, and shepherd's purse. The remedy was most frequently given by inhalation or plugging the nostrils with it as in the case of animal remedies. It was also administered in the form of a plaster, amulet or draught.

Mineral cures. Precious stones such as the amethyst, cornelian, emerald, jasper, pearl and ruby, and minerals such as the bloodstone

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and copper in the form of copper coin were often employed (Fernie). According to Black (183), the common remedy for nose bleeding of slipping a key down between the clothes and the skin, is a relic of a symbolic act of the Norse and connected with Thor

Hydrotherapy in various forms is extensively used in the folk-lore treatment of epistaxis, as is shown by the following methods recommended by Moncrief, Wesley and Hovorka and Kronfeld "great quantities of cold water thrown in the face at diverse times in a short space" (Moncrief, 14), "a very cold water or water and vinegar to the temple and forehead" (*Ibid*), "apply cold water or water and vinegar to diverse parts pouring it upon the arms, putting the feet therein, and applying it to the cuds, as also the back" (*Id*, 15), "drink smiddy water boiled" (*Id*, 221), "drop water on the neck" (*Id*, 222) "Apply to the neck behind and on each side a cloth dipt in cold water" (Wesley, 22), "put the legs and arms in cold water" (*Ibid*), "in a violent case go into a pond or river" (*Ibid*) In Slovakia cold water is dropped into the nose and poured on the nape of the neck (Hovorka and Kronfeld, 1, 7) The Rumanians in South Hungary use a footbath containing bran and salt, 2 (*Id*, 6) According to Rappoport (31), in Brittany sailors believe that the best treatment for a cold in the head is to drink a glass of sea water in the morning and in the evening In Western Bohemia excessive sneezing is treated by washing the hands in warm water (Hovorka and Kronfeld, 1, 4)

Transfer The following supposed modes of transfer of a cold are described by Hovorka and Kronfeld (1, 5) sneezing into a person's shoes, wrapping up a red coin moistened with nasal mucus in a piece of paper and throwing it into the street, when the finder will get the cold, saying to a person in the street, "I give you my cold", and smearing a door handle with the mucus early in the day when the first to turn the handle will catch the cold

Charms Numerous charms and prayers addressed to the Trinity and the Virgin Mary have been employed for staunching nose bleed According to Black (76), the following prayer is to be found in the MS *Iber loci Benedicti de Whalley* (1296 1346) "So may it please the Son of God So His mother Mary In the name of the Father, stop, O blood! In the name of the Son, stop, O blood! In the name of the Holy Ghost stop O blood! In the name of the Holy Trinity" Black (167) also quotes the following passage from Blumler's *Amuletorum Historia* "Cum trina formatione crucis, una cum trina recitatione Orationis Dominicae, et Ave Maria haec verba dicunt Max, Hackx, Lyacx, Jesus Christus Et his credunt profluvium sisti posse" Urban (quoted by Hovorka and Kronfeld, 1, 469) describes the following incantations "Three pious sisters went into the Garden of Olives the first was named Sibyl the second God's will and the third stopping of blood In the name of the Father, the Son and the Holy Ghost"

" There come three lovely maidens
To Earth down from the Sun ;
The first is called Blood-letter [the lancet],
The second is Blood-getter [the basin],
The third Blood-stay ! [the plug].
Blood-go-away !
Blood-have-done ! "

I am indebted to Miss Bellis, Librarian at the Wellcome Research Institution, for this translation.

" Fresh blood stand still like the holy firmament. God help thee." All these charms are similar to or the same as those used for treating fresh wounds.

The following charm, according to E. M. Wright (241), is used in Devonshire. " Repeat nine times these words: ' Blood abide in this vein as Christ abideth in the Church and hide in thee as Christ hideth from Himself.' "

Patron Saints. The only saints, as far as I can find, whose aid may be invoked in case of nasal disease are those mentioned by De Warsage (70) in Belgium, viz. St. Nazaire for the cure of anosmia, probably on account of the first syllable of his name, and St. Fiacre for epistaxis.

Miscellaneous cures. Other forms of treatment for nasal diseases which cannot be classified under any of the previous headings are as follows: (1) Epistaxis. According to Marcellus (X, 60) it is helpful to utter some unintelligible jargon three times in the ear of the same side as the epistaxis. " If one bloede on the right side of the nose and presse hard the parties right little finger that bloede, if on the left then the little finger in like case, therewith bleeding will cease. This is a common and proved remedy " (Lupton, ii, 88).

Wesley (22) is responsible for the following methods: " Wash the temples, nose and neck with vinegar." " Snuff up vinegar and water " ; " foment the legs and arms with it " ; " keep a little roll of white paper under the tongue ".

In Worcestershire to cure bleeding from the right nostril the healer will bow to the patient and press the right little finger, and if the left nostril bleeds he will bow and press the left little finger (Black, 191).

In Shropshire it is the custom to tie the patient's left garter round the family Bible and put a key on the back of the neck (E. M. Wright, 240).

According to Lean (ii, 485), a red ribbon or a skein of scarlet silk worn round the neck is a cure.

Steggerda and Korsch state that the herb doctors of Maya lay the patient's head down in his hammock and wet his forehead with salt and vinegar.

(2) Nasal catarrh. Inunction of the nose with butter, vaseline or tallow is regarded by the folk as a sovereign remedy (Hovorka and Kronfeld, ii, 5 ; McKenzie, 107).

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(3) Sneezing. The contemporary folk-lore remedies for sneezing have been classified by Kanner in the following groups. 1, Suggestions, general or specific, of healers 2, Metaphysical cures; prayers, mental equilibrium, magnetic treatment 3, Cure through fright. 4, External remedies; pressing and rubbing. 5, Local applications to nasal mucosa 6, Spraying, inhaling, sniffing, smelling and gargling. 7, Exhaling 8, Remedies *per os*. 9, Complicated recipes. 10, Hygienic and dietetic measures.

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CLINICAL RECORDS

NOTES ON FIVE CASES OF BRAIN ABSCESS

By B. COHEN (London)

THE manifold problems in the treatment of otogenic brain abscess especially as it occurs in the temporo-sphenoidal lobe are rendered even more complicated at the present time by the wide divergence of view held by aurist and neurosurgeon as to the optimum time to operate and the technique to adopt, but it is becoming more and more evident that this issue is really based on the fallacy that each is presented with the same problem and attempting to solve it along different lines. The position is that each has a different type of case to deal with and differences in approach and technique necessarily follow. The chronic brain abscess accurately and firmly walled off, and often sterile, is a condition having little in common with an active middle-ear and intracerebral suppurative process which the otologist has to deal with. There is, also, frequently an infected dura in the latter type of case. Even the uncomplicated brain abscess met with in aural clinics is usually of a subacute nature and inadequately encapsulated. A comparison of the results of treatment is therefore of no great value.

The train of events leading to brain abscess formation is frequently started by an exacerbation of the aural infection, manifested by pain, otoscopic changes and headache, etc. Pain in chronic middle-ear suppuration is notoriously a danger signal presaging any of a number of complications. The aurist in such cases will of course investigate conditions in the mastoid cavity and should brain abscess declare itself then or soon afterwards it would appear logical to deal with it along the pathway of infection. It is to be noted in passing that rupture of an unsuspected brain abscess commonly occurs after a mastoid operation. This type of case is in clear contrast to the one in which the aural condition is obviously quiescent or has been dealt with some time previously and the abscess is uncomplicated. The problem now is closely similar to that of brain tumour and should be dealt with by a neurosurgeon. The otologist cannot hope to achieve the technique and results of the latter in such a case. A brain abscess in a comatose patient with an active middle-ear infection presents problems in treatment which can only be dealt with by close co-operation between neurosurgeon and aurist, viz. should the brain complication be dealt with first and the aural condition treated at a later date, or should the otologist deal with both by a mastoid approach? The ill effects of bone gouging may be a factor to consider.

An accurate determination of the state of infection in the middle ear is not always possible especially when the mastoid process is sclerotic and

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cholesteatoma is present Case IV illustrates this point where a dry attic cholesteatoma was associated with a major complication It is in such cases that guidance can be obtained from the clinical history, viz pain, headache and vomiting In many cases a mastoid exploration is justifiable on the grounds of clinical history

The following five cases of brain abscess are fairly typical of the kind met with in aural surgery and the results of treatment are correspondingly typical In neither of the two fatal cases is it probable that a neuro-surgical approach would have been successful The condition in both was not diagnosed until a post operative meningitis, severe and progressive, had occurred 'Le syndrome de discordance' is not likely to occur once the brain abscess has ruptured into the ventricular system or subarachnoid space, it may occur if leakage alone has taken place The following case of cerebellar abscess with meningitis illustrates this point

'Child aged 12 was admitted with an acute otitis media of one week's duration and occipital headache There was no history of previous otorrhoea A week later signs of an early meningitis developed and the mastoid was opened Pus was found but the posterior fossa and middle fossa dural surfaces were intact and healthy over a large area Culture of the pus revealed pneumococci The same organism was present in the CSF There was no improvement in the clinical condition which steadily deteriorated and eventually six days later the child was semi comatose CSF pressure was over 350 mm of water and the fluid contained polymorphs and pneumococci Occipital headache was constant Exploration of the temporal lobe and cerebellum was negative Slowly with repeated courses of M & B 693 the child made satisfactory recovery and six weeks after the initial operation was beginning to walk about Headache recurred soon after and a mild weakness in the homolateral arm appeared The child was well and fit Dysdiadochokinesis appeared about a month later in the same limb The cerebellum was re-explored through Trautman's triangle and behind the lateral sinus but no abscess was found The child died during the course of the operation and at post mortem the findings were collapse of a lung and a chronic well encapsulated abscess on the postero inferior aspect of the cerebellum containing inspissated pus

The period of drainage must be gauged by the surgeon's experience and the condition presenting at the time It is to be noted however in the case of many abscesses that once the collection has been evacuated very little if any further drainage of pus occurs In these usually small abscesses it may be sufficient to aspirate, repeating if necessary Drainage however is the only safeguard against further loculation of pus this is especially so in cerebellar suppuration In the cases below a number 10 rubber catheter with side openings was used and stitched to muscle or fascia Prolonged drainage may of course, be necessary for large abscesses Respiratory paralysis in cerebellar abscess is commonly terminal, being due to a medullary conc phase recovery is unusual It occurred in the case reported below and the patient recovered though there was an unavoidable delay of about six hours before the cerebellum could be drained Artificial respiration and elevation of the foot of the bed should be resorted to at once when this occurs

CASE I. Left Chronic Suppurative Otitis Media recurring over a period of two years with recent exacerbation. Left temporo-sphenoidal lobe abscess. Drainage. Recovery

The patient, G.L.G., aged 51, was admitted on 7.6.42 as an emergency to the R.N.T.H. with a history of discharging left ear at intervals over a period of two years. Three weeks prior to admission he developed severe increasing pain in the left ear with recurrence of the discharge, and left hemicranial pain; a neuralgia in the distribution of the upper jaw followed two weeks later. A dental extraction two days before admission had not relieved the pain in the jaw. There was no vertigo or rigor. He vomited once on the day before admission.

Examination. His headache and pain in the jaw are obviously severe. He is a fascile subject but otherwise mentally alert. There is a chronic middle-ear catarrh on the right. On the left there is a chronic suppurative otitis media with polyp, malodorous pus and infiltration of meatal walls. No mastoid tenderness.

Hearing C.V.: R. 4 ft.; L. 3 ft.

C.N.S. All superficial and deep reflexes equally active.

No nystagmus or past pointing.

No Rombergism.

Optic discs normal.

During the next two days temperature varied between 98° F. and 100° F., but at no time noticed to be subnormal; pulse not below 74/min.

The headache and neuralgia persisted, and apart from the appearance of a doubtful right Babinsky sign the reflexes remained normal.

10.6.42. He appears to be mentally dull, articulation has become slurred and he is aphasic. There is no asseveration. The right abdominal reflexes are absent and the right plantar response definitely extensor. Fields of vision full to rough test.

Temperature 99° F. Pulse 78/min. Respiration 22/min.

No signs of meningitis, and general condition good.

Diagnosis—suppuration in left temporo-sphenoidal lobe.

11.6.42. Under intra-tracheal gas, oxygen and ether a left radical mastoidectomy was performed. Findings were cholesteatoma and polyp in a sclerotic process. Tegmen antri et tympani not obviously diseased. Middle fossa dura somewhat congested and tense, pulsating feebly. Part of the temporal squama was resected. Temporal lobe was aspirated from the mastoid and 2 oz. of foul-smelling pus evacuated at a depth of 1½ in. in a direction upwards, forwards and medially. A 10 size rubber catheter with side openings was introduced and stitched to the temporal muscle. Post-operatively 6 oz. of 50% Mag. Sulph. were given P.R.

During the next few days there was a steady lessening of the mental torpitude and aphasia. Temperature varied from 97.7° F. to 98° F. Pulse at times reached down to 68/min. Two days after operation the wound was inspected for the first time. There was no spontaneous drainage from the tube but a little pus was evacuated on gentle syringing with warm saline. The neuralgia persisted for about a week. The aphasia was not present four days after

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operation The plantar reflexes became flexor on the third day, the abdominal reflexes returned a week after the operation

Post operative care consisted of daily rotation of the tube and irrigation with warm saline Every other day the tube was shortened a little

22 6 42 All packs were removed from mastoid cavity and the tube changed for the first time No anæsthetic was used Tube was re inserted to depth of about 1-1½ in

17 7 42 He continued to make an uninterrupted recovery and on this date, i.e. after 5½ weeks, drainage of the abscess was discontinued

5 8 42 Under general anæsthesia the radical cavity was opened up and revised with meatal plastic and secondary suture There was a small hernia cerebri Four hours and eight hours respectively after return to the ward he had rigors lasting about 10 minutes Nothing more eventful occurred until his discharge with a healed middle ear on 22 8 42

May 1943 He has been fairly well in the interim, except for left temporal headaches especially when at work He had been occupied on a strenuous job in noisy surroundings A light job was advised with relief to this symptom The ear was dry

Comment This was a classical case of temporal lobe abscess uncomplicated by meningitis either before or after operation There was no papillædema, and no lumbar punctures were done The Vth nerve neuralgia was an interesting symptom—this is more common with abscesses far forwards in the temporal lobe The period of drainage was rather long, but experience shows that prolonged tubal drainage is never harmful and often obviates pocketing

Chemotherapy was not used This type of case usually recovers.

CASE II *Left Chronic Suppurative Otitis Media Radical mastoidectomy Extradural abscess Post operative rupture of brain abscess Drainage Death*

J H, aged 15 years, was admitted as an emergency to the R N T H with a history of left otorrhœa of 14 months' duration Two months before the onset of the otorrhœa he received a blow on the head For four weeks prior to admission he had pain in the ear, but there had been no vertigo, headache, vomiting or rigor

Examination The details of the drum were obscured by a gross sagging of the outer attic wall, but there was no discharge of pus There was no mastoid tenderness, nystagmus or past pointing Hearing was W V at 3 ft

Temperature 99 6° F Pulse 78/min

29 8 42 Left radical mastoidectomy performed

Findings were—large middle fossa extra dural abscess of foul pus Cholesteatoma in mastoid antrum and middle ear Middle fossa dura very tense and bulging somewhat Lateral sinus normal

30 8 42 Feels ill and complaining of left temporoparietal headache and left retro orbital pain

Temperature 98 4° F Pulse 86/min

Apart from little increased congestion of nasal half of left optic disc, nothing abnormal was found on examination of the C N S

B. Cohen

31.8.42. He is drowsy and speech is a little indistinct. He does, however, answer questions correctly. There is no aphasia. He vomited twice during the night and is complaining of frontal headache and retro-orbital pain on the left side. There was a sharp rise of temperature to 101.6° F. Pulse 110/min.

Examination of the C.N.S. revealed a state of meningitis, the deep and superficial reflexes being equal and fairly active. There was no cranial nerve palsy; the fundi showed some fullness and congestion of the nerve heads.

Lumbar puncture. Turbid fluid.

Pressure $300 + +$ mm. of H_2O .

20 c.c. withdrawn.

Final pressure, 100 mm. of H_2O .

Report. 3,785 white cells/cu. mm.

97% polymorphs.

Direct film. Coliform and gram—ve diplococci.

Culture. Sterile.

Sulphanilamide given—gm. 2 statim, and then gm. 1 four-hourly.

1.9.42. He is semi-comatose and roused only with difficulty.

C.N.S. All deep reflexes subdued.

Abdominal reflexes absent.

Plantar responses flexor.

Fundi—some nerve head congestion.

Cranial nerves normal.

Nuchal rigidity and Kernig's sign present.

Blood pressure 126/68.

Lumbar puncture. Cloudy fluid.

Pressure: Initial 290 mm. of H_2O ; Final 120 mm. of H_2O . 8 c.c. withdrawn.

Report. 71,020 cells/cu.mm.

10% polymorphs.

Culture. Sterile.

The temperature continued to swing between 99° F. and 102° F., with pulse rate varying between 78 and 100/min. There was a temporary improvement in the clinical state until 4.9.42, though he was still very drowsy. The high pressure and cloudy nature of the cerebrospinal fluid persisted. A left external rectus palsy appeared on this day. The plantar responses were still flexor. There was a vertical nystagmus and also a nystagmus to the left. There were no cranial nerve palsies and no muscle limb weakness.

Sulphanilamide was discontinued and M & B 693 given instead.

The possibilities were:

1. Simple post-operative meningitis due to organism resistant to Sulphonamide.
2. A collection of pus either extradural or intracerebral not drained at previous operation.

In view of the further deterioration in the clinical state, already low, further operative exploration was obviously indicated. There were no signs indicating the site of the complication, though the occurrence of the vertical nystagmus pointed rather to an intracerebral one rather than a simple meningitis and of the two cerebral complications a cerebellar rather than temporal lobe abscess.

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4942 Under gas, oxygen and ether the mastoid was re opened and a large temporal lobe abscess found with the escape of pus and disintegrated brain matter The abscess was drained with a No 10 rubber catheter

The patient did not recover consciousness He died the next day No post mortem examination was made

Comment The main feature of this case was the scarcity of symptoms indicating a cerebral complication Pain, only, was complained of, and the presence of an extradural abscess was adequate to account for this The dura in this type of complication is, of course, thickened and tense, but when the extradural abscess was defined, the dura was sagging even more than was commensurate with such a lesion Exploration of the temporal lobe then, might well have saved life, cf Case IV, but there was no real indication to do so, and there was naturally unwillingness to breach the inviolability of the dura across a grossly infected field It is possible that brain puncture prematurely may lead later to the production of a brain abscess

The failure of the meningitis to respond to treatment, the excessively high cell count, and the vertical nystagmus, were the final diagnostic indications The escape of disintegrated brain tissue is usually indicative of a relatively poor chance of recovery In Case IV, however, this occurred but the patient recovered It is to be noted that the plantar responses were constantly flexor

The case bears out again the importance of aural pain in chronic middle-ear suppuration This symptom and the obvious sagging of the meatal roof were indications for an emergency radical mastoidectomy

CASE III Right Chronic Suppurative Otitis Media and recent exacerbation, middle fossa extradural abscess Radical mastoidectomy Temporal lobe abscess Drainage Death

E S, aged 23, was admitted on 13 1 43 to the R N T H with a right aural discharge of some years' duration, and earache and headache of a few days No rigor or vertigo had occurred and she had not vomited

On examination there was an attic polypoidal granulation with some malodorous discharge Slight tip tenderness could be elicited Hearing W V 1 foot There was no spontaneous nystagmus or fistula symptom

With rest in bed the headache and earache in greater part subsided but a week later she had a throbbing pain in the ear, a profuse pulsatory malodorous discharge and definite tenderness over the mastoid process Temperature 101° F Pulse 100/min

22 1 43 Right radical mastoidectomy performed A large extradural abscess was found extending from the sinodural angle up over the tegmen antri on to the temporal fossa The dura was grey and sloughy for a considerable extent upwards and was tense and bulging Aspiration of the subdural space in the region of the mastoid roof released a small quantity of blood and pus and a small incision of the dura at this point was not followed by escape of cerebrospinal fluid There was cholesteatoma and a polyp in the middle ear

23 1 43 Patient looks fairly well, in fact too well She is difficult to control—though not irrational she desires to get out of bed to go home She complains of some throbbing at the vertex and a numb sensation in the occipital

region. Tongue is slightly furred. Temperature 100° F. Pulse 88/min. There was nothing abnormal on examination of the C.N.S.

M & B 693 given gr. 2 statim and then gr. 1 four-hourly.

24.1.43. The patient vomited during the night. She is drowsy and tends to lie on the left side. She still wants to go home but is less clamant about this. Cerebration, though slow, is finally adequate. There is an early aphasia. Tongue very furred. Temperature 99° F. Pulse 90/min. There has been no bradycardia.

C.N.S. All deep reflexes are feeble.

Right plantar response weakly extensor.

Abdominal and pupillary reflexes normal.

There is some past pointing with the left finger. There is a weak Kernig phenomenon but no nuchal rigidity. Cranial nerves normal. Visual fields full. Optic discs normal. Blood pressure 134/56.

Lumbar puncture. Clear fluid.

Pressure—300 mm. of H₂O falling to 205 mm. of H₂O on withdrawal of 10 c.c.

Queckenstedt test positive.

Mastoid cavity satisfactory.

25.1.43. General condition if anything worse—she is more drowsy though co-operative. Headache at the vertex still throbbing.

C.N.S. All deep reflexes obtained except in left ankle.

Abdominal reflexes equal and active.

Left plantar response a doubtful flexor.

Right plantar response flexor.

Kernig's sign in left leg.

Cranial nerves normal.

Fundi—some blurring of left optic disc.

No aphasia or dysdiadokokinesis.

Lumbar puncture. Fluid quite clear.

Pressure—Initial 300 mm. of H₂O; Final 180 mm. of H₂O. 10 c.c. withdrawn.

26.1.43. Seems stuporous and tends to cry, but attention can be obtained momentarily.

Left plantar responses definitely extensor.

Right plantar responses definitely flexor.

Optic discs. Nasal margins blurred and veins full.

No nystagmus.

Diagnosis. Left temporal lobe abscess.

Under light chloroform anaesthesia the temporal lobe was explored. A small abscess was found very deep in the lobe in an anteromedial direction from the temporal surface of the brain. A tube was inserted.

6 oz. of 50% Mag. Sulph. was given P.R.

Patient did not recover consciousness. She died the next day.

Post-mortem. There was a small oval abscess in the temporal lobe with its inner wall close to the lateral ventricle and its long axis vertical. It had ruptured on to the ventral surface of the temporal lobe.

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There was an extensive pericardial effusion and old rheumatic disease at the aortic and mitral valves

Comment Though in this case the acute symptoms abated as a result of expectant treatment in bed, the very fact that they did occur, in the absence of labyrinthine symptoms, should have necessitated immediate operation

There had been earache and headache of a few days' duration Delay in operating may have allowed the extradural abscess to progress further Cerebral suppuration was manifest by post operative meningitis This complication where a labyrinthine focus can be excluded, occurring in an exacerbation of chronic otitic suppuration, especially when progressive, is usually due to a ruptured brain abscess Localizing signs are unusual, the clinical state being that of a profound meningitic infection Recovery is unusual and this type of abscess probably ranks as the commonest in those unsuccessfully treated Early operation and the exhibition of massive doses of Sulphonamide preparations may be successful in the odd case

The abscess in this instance was small and deeply placed

CASE IV *Right Chronic Suppurative Otitis Media with exacerbation Temporal lobe suppuration Drainage Recovery*

F E, aged 15, was admitted on 17 3 43 to the R N T H with a history of right earache of two days' duration For some days previously he had a mild frontal headache and on the day prior to admission he vomited three times There was no rigor or vertigo Eight years previously the ear had discharged for a week but in the interim had apparently given no trouble

Examination He is an active and fit subject

Right ear—normal

Left ear—posterior attic perforation occupied by dry cholesteatoma No mural oedema C V at contact

There is an inconstant nystagmus on deviation to the left and a weak positive fistula symptom No past pointing

Temperature 101° F Pulse 94/min Respiration 22/min

All superficial and deep reflexes normal No meningeal signs

Fundi—not examined

18 3 43 A modified radical mastoidectomy was performed

The findings were a large foul-smelling extradural abscess in the region of the middle fossa dura and sinodural angle with cholesteatoma in antrum and attic Soon after release of this abscess the patient had generalized convulsions The anæsthetic was discontinued but it was obvious within a few minutes that the patient was in coma Ether convulsions were suspected, the observation of a tense bulging middle fossa dura and the onset of convulsions not in the face but in all limbs at once, pointed to a temporal lobe suppuration This was confirmed on puncture, pus and disintegrated brain being aspirated at a depth of 1½ inches A No 10 rubber catheter was introduced and the mastoid cavity packed with BIPP

6 oz of Mag Sulph were given P R in bed

19 3 43 The patient was in coma and restless during the night, but by the morning he was conscious though somewhat drowsy

Temperature 101° F Pulse 88/min Respiration 22/min

B. Cohen

C.N.S. All deep reflexes are subdued.

Both plantar responses are extensor L>R.

Abdominal reflexes are equally active.

No clonus.

Fundi—No papilloedema but right disc slightly congested.

No nuchal rigidity or Kernig's phenomenon.

20.3.43. The drowsiness has almost gone but there are signs of meningeal irritation. Nuchal rigidity and Kernig's sign are present. Plantar responses are extensor.

Under general anaesthesia the skin incisions were extended upwards and backwards, swab taken from drainage tube and lumbar puncture performed, viz.:

Lumbar puncture. Fluid cloudy.

Pressure not high. (Manometer blocked.)

12 c.c. withdrawn.

Report. 100 white cells.

91% polymorphs.

7.5% lymphocytes.

1.5% large mononucleates.

9.5 R.B.C.s seen per 100 white cells.

Protein—80 mgr. %.

Direct smear—few gram—ve cocci.

Culture—streptococci.

Pus from brain. Mixed organisms—chiefly gram—ve cocci in pairs and gram—ve bacilli.

Culture. Streptococci and coliform organisms.

Course of M & B 693 commenced, gm. 2 statim and gm. 1 four-hourly, by mouth.

For the next week the clinical state was that of a mild meningitis with persistence however of the extensor plantar responses.

Temperature varied from 97° F. to 99° F. Pulse 80 to 90/min.

21.3.43. *Lumbar puncture.* Turbid fluid.

Pressure 90 mm. of H₂O.

Fluid not reported upon.

23.3.43. W.B.C. of blood—8.7/cu.mm.

75% polymorphs.

12% lymphocytes.

The report on the bacteriology of the cerebrospinal fluid was received to-day and sulphanilamide substituted for sulphapyridine.

26.3.43. The mastoid cavity was dressed for the first time. Packs changed. No drainage evident from the tube even after irrigation with saline and rotation.

27.3.43. *Lumbar puncture.* Clear colourless fluid.

Pressure 100 mm. of H₂O.

Protein—20 mgr. %.

Chemotherapy was discontinued on this date, 30 gms. having been given.

8.8.43. The patient continued to make satisfactory progress and on this date—that is four weeks after operation—the tube drainage was discontinued.

There was no evidence of meningitis, the only abnormal physical signs being a feeble extensor plantar response on the left. A week later the patient

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complained of a mild frontal headache, vomited, and the temperature rose from normal to 99.4° F

Examination of the nervous system revealed

- 1 No cranial nerve palsy
- 2 All deep reflexes present, possibly more active on the left
- 3 Left plantar responses definitely extensor, the right biphasic
- 4 No nuchal rigidity or Kernig's sign
- 5 Fairly well sustained fine nystagmus to right and left, but no past pointing Hearing—C V contact
- 6 No muscle weakness in the limbs

Lumbar puncture Fluid clear

Pressure 170 mm of H₂O

Cells 0.5/cu mm

Protein 35 mgr %

There was no repetition of the headache or vomiting, but the nystagmus remained though it became less well sustained and at times absent. The plantar responses returned to normal on 25.4.43

27.4.43 The cavity was converted into a radical mastoidectomy, a fine erosion of the lateral canal being found. Meatal plastic and secondary suture were instituted.

16.5.43 Discharged from hospital. Radical cavity moist. No nystagmus present.

23.6.43 Quite fit. Radical cavity adequate—little mucopus from the Eustachian tube, granulations here curetted and cauterized.

21.7.43 Quite well. Cavity is moist. Hearing—C V at 4 inches.

Comment This was an early brain abscess, probably a suppurative encephalitis. The history of acute symptoms was short, pain for two days and vomiting one day. Otoscopic examination revealed a dry attic cholesteatoma, of interest especially in association with a major complication. Again as in Case II an extradural abscess might ordinarily have explained the acute symptoms, and if the coma and convulsions had occurred post-operatively instead of, fortunately, during the operation, a violent post-operative meningitis would have occurred, with, probably, fatal issue.

The coma probably indicated a threatened rupture of the abscess into the ventricular system and a small leakage had perhaps occurred before the abscess was evacuated. The mildness of the post-operative meningitis fits in with this presumption.

CASE V *Left Sub-acute Otitis Media, Occipital Headache and Progressive Coma* *Cerebellar abscess Drainage Recovery*

L B, aged 15 years, was admitted to the R N T H on 16.3.43 as an emergency.

There was a history of two weeks' discharge from the left ear and severe increasing headache over the right occiput, for one week. No vomiting, vertigo or rigors had occurred. Three years previously an aural discharge had followed a bomb explosion and intermittently since then there had been a little discharge. About seven years previously he received treatment for congenital syphilis, but there were no obvious luetic stigmata to be seen and Wassermann reaction

was returned at a later date as negative. A month previously he had been an in-patient with an abscess in the vestibule of the nose on the left side. This responded to conservative treatment and was healed eight days later.

Examination. There was a left antero inferior perforation discharging a little mucopus. There was no mural sagging, though there was some meatal œdema. There was neither pain in the ear nor mastoid tenderness, that is, sub-acute infection. The nose showed a sub-acute congestion of the mucosa, both sides, but no pus. Examination of the C.N.S. revealed no abnormality. X-ray of the para-nasal sinuses showed some cloudiness in the right sphenoid. The temperature was 98° F., pulse 96/min. and respiration 20/min. Three more obvious possibilities presented themselves in diagnosis:

1. A complication of otitis media.
2. Right sphenoid sinusitis.
3. Metastatic brain abscess, from the previous vestibular abscess even though this was quite healed.

16.3.43. On the day of admission the mastoid was explored and cortical operation performed. The bone was feebly cellular and only some debris and granulations found. The middle fossa dura and lateral sinus each exposed for 1 inch were both healthy.

Right sphenoid puncture—clear return.

17.3.43. Rise of temperature to 99.2° F. Pulse 130/min.

Occipital headache still intense. He appears to be dull and a little drowsy.

C.N.S. All superficial and deep reflexes normal.

Cranial nerves normal.

No nuchal rigidity or Kernig's sign present.

18.3.43. The temperature rose to 103° F. Pulse 128/min. Patient more drowsy, irritable, and crying out with pain in the occiput. He had a secondary hæmorrhage from the skin edges, which required ligaturing under general anæsthetic.

Lumbar puncture. Clear fluid.

Pressure 170 mm. of H₂O.

Queckenstedt's positive.

19.3.43. Temperature 101° F. Pulse 128/min. (No bradycardia had been recorded.)

Patient is semi-comatose, very restless and irritable, and incontinent of urine. Headache is bitterly complained of.

C.N.S. All deep reflexes present though subdued.

Abdominal reflexes normal.

Plantar responses flexor.

No limb pareses; difficult to estimate muscle tone owing to semi-comatose state.

An incomplete peripheral right facial weakness has been noticed once.

Fundi normal.

19.3.43. *Lumbar puncture.* The pressure was exceedingly high, the fluid overflowing the top of the manometer. A few c.c. were withdrawn, but the patient had a respiratory failure, which responded, however, to artificial respiration in about two minutes.

Report. Clear colourless fluid.

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Total white cells, 77/cu cm

Total red cells 4/cu cm

Polymorphs, 28%

Lymphocytes, 70%

Monocytes, 2%

Protein, 50 mgr %

Culture—² pneumococci from broth (gram positive diplococci)

This medullary cone phase indicated naturally an internal hydrocephalus. Its rapid onset in the absence of a corresponding papilloedema suggested a subtentorial lesion. The occipital headache and the healthy appearance of the middle fossa dura rather completed the picture. A temporal lobe abscess however is notorious for its simulating signs and symptoms and could not be entirely excluded. In this connection the contra lateral facial weakness though seen only once would have fitted in with the latter condition.

The mastoid was re opened under light gas and oxygen. The temporal lobe was punctured through the roof of the antrum no pus was obtained. On puncture of the cerebellum through Trautman's triangle in a direction downwards and backwards, pus was obtained at a depth of 1 inch approximately. About 10 c.c. were removed and a No. 10 catheter introduced, held in position by BIPP packs.

20 3 43 He is much less drowsy, though subdued. Headache no longer present, pulse of good volume. Draining cerebrospinal fluid through dressing.

21 3 43 Patient looks and feels better, only slightly drowsy. Pulse dicrotic. Blood pressure 120/70.

C N S Deep reflexes more active on left than right.

Plantar responses flexor.

Abdominal reflexes weak.

Cranial nerves normal.

No papilloedema.

There is some loss of muscle tone in the left arm, but no dysdiadokokinesis.

To facilitate better drainage, the lateral sinus was obliterated between BIPP packs and part of the labyrinthine block removed. There was no pus on suction of the cavity. The tube was re-introduced and stitched to the skin edge.

22 3 43 He had some frontal headache during the night, but otherwise feels fairly well. There is a fine horizontal nystagmus to the left and possibly some past pointing with the left.

Dysdiadokokinesis is present in the left arm.

25 3 43 The nystagmus has shifted to the right and there is no past pointing.

Left arm atonia and inco-ordination are still present.

26 3 43 Cavity dressed all packs changed.

There is a small cerebellar fungus and the abscess cavity is now superficial and dry.

Tube re inserted.

30 3 43 Packs changed.

No pus on tube suction.

B. Cohen

3.4.43. Drainage of cerebellar abscess discontinued, that is after 15 days. The short period of drainage was decided upon in this case because of the small size of the abscess and the rapid clearing of the cerebellar signs.

28.4.43. Patient has developed an early right basal pneumonia. This responded satisfactorily to routine treatment.

25.5.43. Operation cavity almost healed.

Patient quite well.

Temperature, etc. Temperature 99.4° F. on admission, but on the whole the illness ran an apyrexial course. In the first few days the pulse occasionally fell to 60/min.

2.6.43. Mastoid quite healed.

Patient well.

20.7.43. Patient quite well and fit.

Comment. This cerebellar abscess showed no signs of inco-ordination, etc., prior to admission—these appeared after drainage had been instituted. The acute aural symptoms had been present for two weeks. A significant feature of the case was the rapid increase in intra-cranial pressure, no papilloedema to indicate its presence, and no correspondingly severe coma, culminating in a medullary cone phase. Fortunately this latter accident was overcome by artificial respiration and elevation of the foot of the bed; still more so in the absence of more positive clinical evidence, it supplied the real clue to the elucidation of a puzzling state. Very little disease had been found on mastoid exploration, viz. no lateral-sinus thrombosis, extradural abscess, labyrinthine infection or even pus in the mastoid, and some obscure form of meningitis was being considered.

Treatment of the abscess was along orthodox lines; suction was adopted; the tube changed three times and finally removed on the sixteenth day. Chemotherapy was not made use of, the cerebral infection being an uncomplicated one. Apart from the mild pneumonic infection the post-operative course was uneventful.

My thanks are due to the various surgeons of the Royal National Throat Hospital for permission to treat and publish the notes on these cases. I acknowledge, too, the helpful suggestions and advice on the presentation of this paper given by Mr. F. Watkyn-Thomas.

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SERIOUS EPISTAXIS

By G N BARKER (Cheltenham)

THE vast majority of cases of epistaxis respond to the usual local measures employed, and it is seldom that cause for anxiety occurs. In the last two years I have had two cases which were uncontrolled by packing and were so severe that recourse was made to ligation of the external carotid artery. As both cases recovered it appeared to me to be a justifiable procedure. On looking up the available literature to see if the indications for surgical intervention were paralleled, I found that relatively few cases have been reported. The details of my two cases are as follows.

Both occurred in young adults following injury to the region of the external nose, and in neither case was there a history of serious illness in the past or a tendency to undue or prolonged hæmorrhage following injury.

The first case was that of a farm worker who was hit on the bridge of the nose by a hayfork. Epistaxis from the right side occurred at the time of the accident but ceased spontaneously. During the next five days recurrence was severe, and part of this time was spent in the local Cottage Hospital with the nose packed anteriorly and posteriorly. The hæmorrhage persisted in spite of the packing, and so he was transferred to the Department at Cheltenham. I found the nose to be effectively packed, but the hæmorrhage still continued. I removed the packs, but was unable to see the bleeding point owing to a septal deflection, but the hæmorrhage was definitely arterial in type and high up and posteriorly in the right nasal cavity. Both clinically and radiologically there was no evidence of bony injury. The patient's general condition was fair, his blood pressure was 116/60, hæmoglobin 40% and red blood corpuscles 2,680,000. I replaced the anterior and posterior nasal packs, but in spite of what I believed to be efficient packing the hæmorrhage recurred freely on the two succeeding days and on the third day after admission his condition could only be described as grave. As the hæmorrhage was still continuing, the right external carotid was ligated just above the bifurcation that same evening under general anæsthesia (O E J McOustra and G N Barker), and a drip transfusion was started in the theatre and continued in the ward. There was no recurrence of the hæmorrhage following removal of the packs the next day, and the patient's convalescence was uneventful although prolonged.

The second case was a female, and was similar except that there was definite fracture and displacement of both nasal bones, although the hæmorrhage originated solely from the right nasal cavity. In addition the patient was five months pregnant, but this factor produced no complications, either at the time or subsequently. Ligation of the external carotid just above the bifurcation was performed (J S Robinson and G N Barker). A slight hæmorrhage

followed removal of the packs the next day, but there was no subsequent recurrence and convalescence thereafter was uneventful.

It is seen that both cases had a successful termination, and it would appear that the surgical intervention did play a part in causing cessation of the hæmorrhage. It occurs to me, however, that there are several debatable points, and to illustrate these I give a brief summary of two reported cases :

The first¹⁰ was a case of severe epistaxis following fracture of the nasal bone and nasal process of the maxilla, and terminated fatally. At post-mortem examination the source was found to be a ruptured ethmoidal artery.

Comment. As the severity of the hæmorrhage precludes any exact diagnosis of its origin during life, then recourse to ligation of the external carotid artery must always be regarded as somewhat of an experimental procedure, as although this vessel is responsible, *viâ* its sphenopalatine branch, for the major portion of the arterial supply to the nose, it is quite evident that ligation would have no effect on the ethmoidal arteries, which are branches from the internal carotid artery, and in the case reported above, the suggestion made of trans-orbital ligation of the anterior ethmoidal artery is the only feasible plan.¹⁰

The second case⁹ was one of traumatic nasal hæmorrhage requiring ligation of the external carotid artery, but hæmorrhage recurred on the fifth and seventh post-operative days. The packs were then left in position for ten days and transfusions given, following which the patient made an uneventful recovery. The reporters of this case comment that the re-establishment of the circulation from the opposite external carotid artery was evidenced by the recurrence of the hæmorrhage from the nose on the fifth day after ligation, and state that had it been found necessary, ligation of the external carotid artery on the opposite side should have been performed.

Comment. I feel that it is fair to comment here that whereas the recurrence of the hæmorrhage was probably due to re-establishment of the circulation, one cannot exclude the possibility of the source of the hæmorrhage being in whole or part one of the ethmoidal arteries, and that cessation was either spontaneous or aided by the prolonged nasal packing and transfusion.

These two cases illustrate the points I wish to make—namely that although ligation of the external carotid artery, to judge from the reported cases, is a justifiable procedure and likely to be crowned with success in many cases, it will not influence hæmorrhage from the ethmoidal arteries or those cases where the circulation is rapidly re-established.

Some observers^{3, 4, 5} have discussed the arrest of severe nasal hæmorrhage, and whilst conceding the practicability of ligation of the external carotid artery in these cases, maintain that it is not sufficiently reliable because of the efficient collateral circulation in this area. They hold that transantral ligation of the internal maxillary artery is more effective, and quote cases to support their contention that it affords an opportunity to cut off the arterial supply as close as possible to the site of the hæmorrhage. Personally I have not had an opportunity of using this method of ligation of the internal maxillary artery, which from the cases reported appears very successful, but my investigations make it clear that a good deal of dissection practice is necessary to achieve the speed necessary in these exsanguinated cases.

Clinical Records

Summary

Two cases of nasal hemorrhage necessitating ligation of the external carotid artery are described. The alternative method of transantral ligation of the internal maxillary artery is on theoretical grounds likely to be more efficient, but would appear to present certain technical difficulties.

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SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

Friday, March 5th, 1943.

President—V. E. NEGUS, M.S.

The Prevention of Pyogenic Infections of the Nose and Throat.

Professor A. FLEMING, F.R.S.

INFECTIONS of the nose and throat are among the most important of human infections and are probably responsible for more sickness than infections of any other region. Fungi, bacteria, or viruses may be responsible for these infections. The only important fungus infection is thrush. Virus infections, such as influenza or measles, are of extreme importance in public health, but they belong more to the realm of general medicine than to that of the otological or rhinological specialist, so I will confine my remarks to bacterial infections. We shall see when we consider the mode of spread of respiratory infections how much more difficult it is to control than any other type. For this reason they are widespread, but some elementary precautions which are often neglected can materially assist in their prevention.

Bacteria in the normal nose and throat.—The nose, apart from the anterior nares, is in health a relatively sterile cavity. Large amounts of contaminated air are normally inhaled through the nose which serves as a filter and removes most of the bacteria. I will return to the methods by which these are disposed of.

The anterior nares is normally infected with a considerable number of organisms, especially staphylococci and diphtheroid bacilli. The diphtheroids are usually of the Hoffmann's bacillus variety, which are little, if at all, pathogenic. As regards staphylococci, it has been found that at birth the nose is sterile, but after two weeks some 90% of infants in hospital wards harbour *Staphylococcus aureus*. With advancing age the number diminishes, being 50-60% in young children, and 20-40% in young adults (Miles, *Lancet*, 1941, i, 507). At St. Mary's we have found that in young healthy men, such as medical students, some 25% carry in their anterior nares staphylococci which are coagulase-positive and toxigenic, and are therefore presumably of the pathogenic types. It is of interest, however, that in patients suffering from recurrent attacks of boils the percentage carrying pathogenic staphylococci is much higher (up to 75%) and it may well be that this is a reservoir of staphylococci from which various parts of the skin are infected by the finger nails.

Postnasal space. It is difficult to know what is a healthy postnasal space, as we all live in such unhealthy surroundings that a very large percentage of us

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have a chronic catarrhal condition. In the ordinary "healthy" person cultures from the postnasal space may show staphylococci, streptococci (especially the viridans type), pneumococci, gram negative cocci, and bacilli of the type of the influenza bacillus. In regard to this last species, Maclean and myself in 1930, by the use of penicillin as a differential bacteriostatic, discovered that it was a constant inhabitant of the mouth and postnasal space of "healthy" students.

Throat—The tonsils are, as you all know, infected with large numbers of organisms. The structure is such that certain more or less saprophytic bacteria as well as the pathogenic types can find a suitable pabulum and flourish outside of the tissues, but protected from any application which merely flows over or washes the surface.

Normal protective mechanism—As the healthy nasal cavity is sterile, or nearly so, it is clear that there must be a powerful antibacterial mechanism, for every day we breathe in through our noses a vast quantity of air containing bacteria, which bacteria are largely filtered from the air in the nasal cavities. In 1923 I showed that nasal mucus, in common with other human secretions, contained a ferment (lysozyme) with powerful bacteriolytic powers which acted especially on the bacterial types which were common in air. This ferment was discovered by the observation that in a culture plate on which nasal mucus had been spread there appeared an extraordinary inhibition of growth of a contaminating air-borne coccus. This coccus, which I named *M. lysodeikticus* from its capacity for being dissolved, has been very extensively used for the study of lysozyme. The ferment is found in great concentration in nasal mucus, in sputum, and especially in tears, and it might interest you to see the rapidity with which it can dissolve sensitive bacteria. To 1 c.c. of a milky suspension of the test coccus there is added one drop of a threefold dilution of nasal mucus. If this is done at a temperature of 45° C., then within 30 seconds lysis is obvious, and within 2 minutes the milky suspension becomes water-clear. Not only is this ferment present in the secretions, but it is also found in abundance in cells such as leucocytes, and in cellular organs such as tonsils. I do not think there is any doubt that this ferment, lysozyme, which has been shown to act on bacterial carbohydrate, is one of the important methods by which air-borne bacteria are destroyed and dissolved in the respiratory tract.

Here I might illustrate an experiment I did many years ago, and which I have published in relation to dentistry. Saliva, as well as nasal mucus and sputum, contains lysozyme, and when it is embedded in an agar plate which is planted with a sensitive organism (*M. lysodeikticus*) the lysozyme diffuses into the agar and inhibits growth of the organism over a considerable distance. If a commonly used antiseptic such as Eusol is embedded in the same way in an agar plate it likewise diffuses out for a short distance and inhibits growth. If, however, saliva and Eusol are mixed and embedded in the agar there is no inhibition—Eusol destroys the lysozyme and it is itself destroyed by the proteins of the saliva. This is an experiment which, I think, should be borne in mind when there is a temptation towards the indiscriminate use of antiseptics.

Lysozyme, of course, is not the only natural antiseptic in the nose and throat, and it is probable that the phagocytic cells are much more important as regards serious pathogenic bacteria which have more or less acclimatized

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themselves to lysozyme. Another experiment somewhat similar to the last may be of interest as showing the relative effect of some chemical antiseptics on phagocytes and on bacteria. Human defibrinated blood is infected with staphylococci. Serial dilutions of T.C.P. are made in saline and to these equal volumes of the infected blood are added, mixed, filled into slide cells and incubated. Figure 1 illustrates the result. In the control cell containing only blood and normal saline (no T.C.P.) no colonies develop—the phagocytes deal with all the cocci. As the concentration of T.C.P. increases so the number of colonies increases until in a concentration of 1 in 4 all the cocci grow. This experiment might also provide a lesson for those who indiscriminately prescribe antiseptics. T.C.P. has been taken merely as an example of a much-advertised antiseptic which is recommended to be used as a gargle in a dilution of 1 in 5. Most of the older antiseptics give essentially the same result.

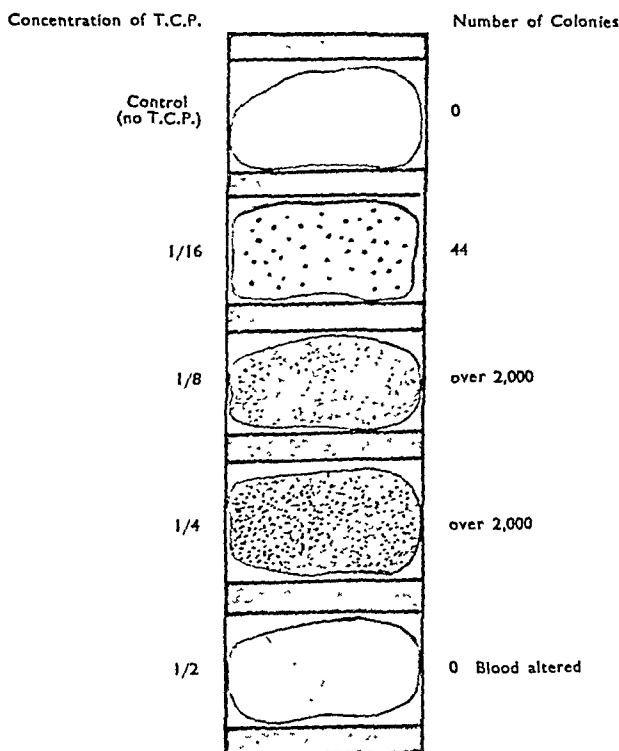


FIG. 1.

Effect of T.C.P. on bacterial growth in human blood.

Methods of spread of nose and throat infections.—This problem has been very much mixed up with the general problem of hospital infection. In the pre-antiseptic days it was well known that in a ward one patient's dressings would be blue (from a *B. pyocyaneus* infection) and in a few days all the patients in the ward would have blue pus. In the last war I pointed out (with Porteous)

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that, whereas in a casualty clearing station only a small percentage of wounds contain hæmolytic streptococci, after they had been in a base hospital for a week practically all contained this organism. We made it clear, and it is on record in the History of the War, that this universal hæmolytic streptococcal infection occurred in hospital. Little notice, however, was taken of it. *Streptococcus pyogenes* is, as you all know, one of the most important of the pyogenic infections, and affects all regions of the body. Wright, in his work on septic wounds in the last war—work in which I had a part—divided the bacteria infecting these wounds into two main classes—serophytes, which grow out readily in unaltered blood fluids, and serosaprophytes, which grew badly in unaltered serum but luxuriantly when this had been corrupted by reduction of its antitryptic power or alkalinity, or by some other change. The streptococcus *pyogenes* was found to be the pre eminent serophyte, which might easily account for the freedom with which it passes from patient to patient. More recently Lancefield introduced her grouping of hæmolytic streptococci, and showed that Group A corresponded with the streptococcus *pyogenes* of human infections. Then Griffith subdivided this Group A into some 30 different types. This extensive subdivision of the streptococci has enabled the source of an infection to be traced, and in regard to puerperal fever, scarlet fever, septic wounds, and other diseases, extensive and important observations have been made which throw much light on the methods of transfer of bacteria from one person to another.

While most of this work has been done in connection with hæmolytic streptococci some very important observations have been made in regard to diphtheria. The antigenic classification of the staphylococci is just beginning, and it may well be that in the next few years we shall be able to trace a staphylococcal infection to its source just as we can a streptococcal one.

The actual sources of the infection may be

- (1) Clinical case of the disease
- (2) Missed case
- (3) Incubating case
- (4) Carrier (possibly most important as least likely to be detected)

The methods by which a throat or nose patient may pass on an infection are very numerous, but they can be classified as follows

- 1 Infected material may be expelled from the nose or mouth in coughing, sneezing, etc
- 2 Fingers may be directly infected by contact with secretions
- 3 Handkerchiefs, certain parts of the clothing, or toys, may similarly become infected

1 When a patient coughs or sneezes he expels droplets large or small, infected and uninfected. The larger ones drop quickly and usually settle on something within a foot or two of the patient, on clothing, bedding, floors, books, or toys. There they dry. The very small droplets evaporate in the air, and the dried residue (droplet nuclei) may float for relatively large distances by currents of air before settling down as minute dust particles. It may be that most of these are uninfected, but the potential danger remains. The infected droplets (we need not consider the uninfected ones) which fall on floors or walls

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become part of the dust which is disturbed each day when the wardmaid sweeps the room. It has repeatedly been shown that the air contains a very much larger number of pathogenic bacteria after the floor is swept than it did before. Daily dry sweeping therefore constitutes a definite danger, and as the dust particles are dry they are likely to float much farther from the patient than the original droplets.

The infected droplets which settle on the bedclothes dry there, but the streptococci (or staphylococci or diphtheria bacilli) are still viable. While the bedclothes are more or less at rest these dried droplets are not disturbed, and stay put, but when the bed is made and the sheets and blankets are shaken out then dust from these blankets, including the dried, infected droplets, is scattered into the air to be taken where the wind blows it. All the many observations which have been made agree that bedmaking increases the number of pathogenic bacteria in the air, and I might quote a recent paper by Hare and Willet (1941) in the *Canadian Medical Association Journal*: "We have exposed blood plates in a ward while the bed of a case with a discharging mastoid was being made. In the first series of exposures the nurse made the bed with a minimum of disturbance, quietly rolling the blankets and sheets off and avoiding any shaking of them. In the second series the bed was made with all the usual violence beloved of an efficient and hurried nurse. . . . The number of colonies on the plates was 23 times greater during the violent bedmaking than during the quiet one. . . ." It must not be forgotten that in this violent bedmaking not only are the microbes scattered in the air but they contaminate also the nurse's hands and garments, and on these can be carried to the neighbourhood of other patients.

It has been estimated that in floor sweepings of a nose and throat ward, 100 million hæmolytic streptococci are present. The blankets of patients with upper respiratory tract infection may contain $\frac{1}{2}$ to 1 million hæmolytic streptococci each.

I might relate a story of hospital diphtheria infection which has been communicated to me by my colleague, Dr. M. Y. Young. In a certain ward in an emergency hospital, cases of diphtheria occurred, and in spite of many precautions they continued to occur. The ward was therefore shut up. The walls were washed down, the ward was fumigated, and all the blankets and bedding were sent to be sterilized. Before the ward was reopened, culture plates were exposed in the ward (at the instance of Dr. Young) while the beds were vigorously made. These culture plates showed colonies of the same type of diphtheria bacillus which had been infecting the ward. The matter was further pursued, and it was found that non-sporing organisms (staphylococci) placed in the municipal sterilizer along with blankets and bedding were not killed. Here, then, the hospital infections were kept going by inadequate sterilization of the bedclothes of the patients.

The conveyance of infection from clothing, handkerchiefs, books, or toys is obvious, and I will say nothing more about it except that it is not, I think, generally appreciated that actual contact with the infected articles is not necessary. A person waving handkerchief or clothing or violently flapping an infected book, will let infected dust escape into the air, which may reach someone else who has not actually touched the articles.

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2 The fingers of the infected individual may become infected either by direct contact with the infective secretions or by droplets. It is almost inevitable that they should be infected in the latter method owing to the use of the hand to shield the mouth when coughing. These infected fingers may obviously pass on the pathogenic organisms in a great variety of ways, and there is no doubt that many wounds have been infected in hospital from the fingers of an attendant who has been a carrier of an organism such as the hæmolytic streptococcus, and who has not taken all the precautions advocated in the M R C memorandum (No. 6) on the dressing of war wounds.

Here is an example which has occurred only recently, and for which I am indebted to my colleagues Dr. Porteous and Dr. Young. Diphtheria prophylaxis was being carried out by a public authority, and in the 75 children done at four sessions by one medical officer, 33 developed abscesses in their arms and some were seriously ill, 15 of these were examined and were found to contain a hæmolytic streptococcus Group A, type 11. Three days after the first session the medical officer had a cold and was found to have a hæmolytic streptococcus (not typed). A later swab from the throat showed a streptococcus Group A, type 11. One syringe and two needles were used at each session. They were boiled before the session commenced. The needle was changed after each patient, and placed in spirit. It was picked out of the spirit with the fingers, rinsed in boiled water, and replaced on the syringe. The easiest supposition in this case is that the medical officer contaminated the water with her infected fingers in rinsing the needles (this might have been added to by droplet infection of the water). The needles got infected and probably the interior of the syringe also. That only some of the children developed abscesses could easily be understood if the infection was not too large. Some would have sufficient immunity to deal with the infection, and others would not. This is not the first time that syringes have become infected from "sterile" water which had been contaminated by the doctor or nurse who was an undiscovered carrier of hæmolytic streptococci.

It has been shown that as many as 70% of scarlet fever patients become infected in hospital with hæmolytic streptococci other than those with which they entered the hospital, and Glass and Wright (1938) have found that 68% of diphtheria patients who had been in hospital for over two months became infected with diphtheria bacilli of types different from the original infection. One case they published is illustrative.

On admission	No diphtheria bacilli found
4 days later	Mitis type
3 " "	Mitis type
18 " "	Intermedius type
35 " "	Gravis type
30 " "	Gravis type
13 " "	Gravis type
21 " "	Intermedius type

These, and very many such observations, make it clear that it is very easy for cross infections of patients to take place in hospital (or for that matter in the home).

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To understand the epidemiology of throat and ear infections with hæmolytic streptococci it is necessary to know the different clinical manifestations of infection with this organism. It varies from a fulminating septicæmia to something which is unnoticed by the patient. The following is an incomplete list: Puerperal fever, scarlet fever, tonsillitis, rhinitis, mastoiditis, bronchopneumonia, erysipelas, subcuticular whitlow, paronychia, impetigo, septic wounds, burns, carriers with no symptoms, especially throat carriers.

If a patient has an acute sore throat and a rash he is diagnosed as a case of scarlet fever and sent to a fever hospital. If he has an infection of the same streptococcus, but only a sore throat or any of the other manifestations enumerated above, he is kept in the ordinary ward, but there is no difference in the infectivity in the two cases. These minor streptococcal manifestations must not be neglected, for they can infect bedding and dust, and spread the streptococcal disease.

Prevention of infection.—This may be attempted in several ways:

- I. Prevention of the infecting bacteria reaching a possible infectee.
- II. Increase of the resistance of possible infectees.
- III. Treatment of the infected individual so as to render the infective period as short as possible.

I. In regard to this, anything will help which will break the chain leading from the infector to the infectee. If it is impossible to prevent the patient spreading bacteria around him such measures as are possible should be taken to prevent their reaching a susceptible individual. I need not go into all the methods used. Authoritative publications have appeared as regards ward planning, ward routine, and air sterilization, but much can be done by simple methods such as: Avoid dust raised by violent bedmaking and by dry sweeping of floors or dry dusting of walls. It may be that some preparation more favoured by nursing sisters than spinkle oil will be discovered that will solve the sweeping problem. Efficient masking of medical and nursing attendants, or of the patient, is of obvious value. Soiling of the fingers of the doctor or nurse can be avoided by following the directions in the M.R.C. memorandum on Wound Infections, and not touching anything infected with the fingers, but with the forceps.

II. Possible infectees may be immunized against a particular infection, but it is impossible to immunize completely against all the nose and throat infections that may occur. It has been shown that man can be immunized against pneumococci, and there is a considerable amount of clinical evidence—not, however, such as will be accepted as conclusive by the statistician—that the resistance to streptococci and the influenza bacillus can be likewise increased. There are at present observations being made in certain institutions in which a proportion of the inmates have been immunized against the prevalent types of hæmolytic streptococci. Immunization is hindered by the multiplicity of types of streptococci or pneumococci, but there is evidence that a certain amount of species immunity can be obtained irrespective of the type immunity.

Normally we have a considerable degree of resistance against the ordinary infections, and although this resistance may be enhanced it seems unlikely that a degree of immunity can be obtained which will resist a very large and virulent infection. It is well known that an abnormal nose or throat predisposes

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to infection, so it is clear that the risk of infection will be reduced if the patient's resistance is increased by the surgical removal or correction of the abnormality

III *Treatment of the infected individual* (a) *Surgery* This is not my province. The bacteriologist is, however, frequently called upon to confirm the shortening of the infective period brought about by surgical measures

(b) *Chemotherapy* This may benefit the patient's clinical condition much more than his position as a distributor of infective bacteria. The sulphonamide drugs, and more recently penicillin, have sometimes the most remarkable effect in limiting a spreading infection, but when a man is merely a throat carrier of hæmolytic streptococci the general administration of the sulphonamide drugs has not had the same dramatic success

Local chemotherapy—Some two years ago it was shown that frequent use of a sulphathiazole snuff had a remarkable effect in eradicating chronic nasal infections of staphylococcus, streptococcus, and pneumococcus, and it has also been used with success by Fry in nasal diphtheria carriers

Penicillin snuff was found to be even more successful, but the supply of penicillin has been so small hitherto that these observations have not been pursued. It may be of interest to know that the first time penicillin was used clinically was in an infected antrum in 1929. A colleague of mine had an antrum infected with staphylococci and influenza bacilli. Penicillin (the crude culture filtrate) was introduced into his antrum once on each of two successive days. Subsequent cultures showed that the staphylococci had disappeared but the influenza bacilli persisted

Sulphathiazole snuff for treatment or prophylaxis seems to me a simple and practical method, and the results so far published indicate that it is effective

In dealing with tonsillar infections one difficulty has been to devise a method whereby a sulphonamide drug could be kept in contact with the surface for a sufficient time for it to exert its antibacterial effect. Gargling is useless, as the contact is very short and the action of the drug is slow, but we attempted to obtain a long contact by incorporating sulphapyridine in chewing gum. We chose sulphapyridine as it was the least soluble of the common sulphonamides and therefore would remain longest in the gum. Half a tablet of the drug was incorporated in each tablet of chewing gum (if more was put in the gum rapidly fell to pieces). It was found that during the chewing an appreciable amount of sulphapyridine was present in the saliva, and after being vigorously chewed for two hours there was still a fair amount of the drug left in the gum. This chewing gum was used by a considerable number of students and nurses who had hæmolytic streptococcal throats, but it was very difficult to assess the results. In some the streptococci rapidly disappeared in others they persisted (but that was to be expected as in some the infection was deep in tonsillar crypts, well away from any superficial application). However, chewing gum containing sulphapyridine offered some hope of a more or less continuous application of a sulphonamide to the surface of the tonsils. It was very popular, and it may have helped by preventing cigarette smoking while the gum was being chewed

In this connection there is a possibility of general or local chemotherapy being used as a prophylactic in special circumstances. It has been shown that small doses of sulphanilamide taken over a long period prevented recurrences

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of rheumatic fever, and it is stated that sulphathiazole snuff, while it may not prevent a cold, can yet prevent the purulent infection which so commonly follows after a few days.

Active immunization and combined chemotherapy and immunotherapy.—Active immunization by means of vaccines has in the past been extensively used in the treatment of chronic septic conditions, and from a long experience I have no doubt that this treatment is often successful. The advent of the sulphonamides has, to my mind, made vaccine treatment of even greater importance. We know that vaccines sometimes succeed—we know that sulphonamides sometimes succeed; but we know that they sometimes fail.

There is ample evidence, however, that a combination of sulphonamide therapy with immunotherapy gives results far better than either alone. The ideal combination would be first an increase in immunity by vaccine, and then to give sulphonamide treatment. I am afraid that nowadays it is generally done in the reverse order—sulphonamides are given, and if they fail a vaccine may be tried. This, of course, is not a combined treatment, as before there is an increased immunity the sulphonamide would have disappeared, but it might well have left behind it a streptococcus which had become resistant to the drug, so that a second course of the drug, even after the patient's immunity had been increased by the vaccine, would be without effect.

Bacteriology for nurses.—Lastly, in the prevention of these infections a most important thing is the education of the nursing staff in simple bacteriology. Medical students learn at least some bacteriology, and I should not advocate for nurses a course so elaborate and extensive. They should, however, have some knowledge of the bacteria which inhabit the various parts of the body, bacteria in the air, on blankets, etc., methods of sterilization, the manner in which infections are spread, and practical matters of this sort. They would then be able more easily to understand the precautions necessary for the prevention of the spread of infection from patient to patient, or from attendant to patient, and I am sure that if they had such a knowledge of the directions in the M.R.C. memorandum on infection, the fingers of the doctor and nurse c

The Clinical Aspect of the Prevention of Pyrogenic Infections of the Nose and Throat

E. D. D. DAVIS

THE streptococcus and the pneumococcus are the most predominant organisms found in acute infections of the nose and throat. The staphylococcus aureus is found in chronic suppuration of the sinuses. Influenza, scarlet fever and measles patients are more susceptible during convalescence to streptococcal complications such as otitis media. It is presumed that they have a phase of lowered resistance or immunity. The streptococcus and pneumococcus have been present in acute upper respiratory catarrh or the common cold which makes prevention more desirable and important.

The universal prevalence of streptococcal and pneumococcal infections and also the absence of severe illness in some cases, makes prevention difficult. Some of these patients do not come under observation until a complication such as sinusitis, otitis media or pneumonia develops.

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Isolation is often impracticable and too expensive in personal restrictions to receive general adoption but at the same time more could be done to prevent infection than is usually the case. For example, greater efforts could be made to prevent or restrain epidemics of streptococcal infections which occur in schools and institutions. The usual health certificate required by schools at the commencement of each term should clearly state that the pupil is not allowed to return with a cold or even a slight sore throat. The conscientious co-operation of the parents is, of course, essential. Isolation in schools and institutions is a practical proposition and the wearing of masks for the nose and mouth in and out of the sick-room should be encouraged. It is fully recognized that infection is spread by droplets and by the contamination of the air of tubes, buses, public meeting places, wards, etc. The study of the prevention of air-borne infections known as aerobiology is a very important adjunct to public health. It includes the ventilation and air conditioning of public rooms, the circulation of dust, the purification of air by ultra-violet light and by chemical means such as a harmless spray of propylene, glycol, etc.

Mothers bring children to see us, complaining of frequent colds of streptococcal origin for which we can find no local cause. Some of them have had tonsil and adenoid operations. We give advice, firstly to prevent infection and secondly to increase the resistance and immunity of the patient, most of which are matters of general hygiene. The diet, including extra milk, cod-liver oil, vitamins, ultra-violet light and anti catarrhal vaccines, etc., receive consideration.

Many such details of prevention and of increasing the immunity will occur to you, even so far as the management and purification of the swimming bath and the pasteurization of milk.

It is stated that cases of streptococcal infections of the nose and throat have an *incubation period* of two to four days, but how long a streptococcal patient is infectious is not known. It is suggested that he is a source of infection during the period of fever. The immunity produced by anti-catarrhal vaccines is claimed to be about seven to twelve months. It is difficult to assess the value of these vaccines, and many bacteriologists doubt their efficiency.

Some bacteriologists consider that the *carrier* is a greater source of infection than the contact with the infected patient. The question of the carrier arises frequently in practice. A nurse about to enter a midwifery ward is required to have a swab taken of her throat and nose, and if hæmolytic streptococci are found she is sent to the nose, throat and ear department for the discovery of the source of the infection. It is also suggested that her tonsils should be enucleated. It is known that hæmolytic streptococci can be found in the pharynx or nasopharynx for as long as six weeks after a cold, equally in patients who have had their tonsils enucleated and those who have not. The throats of 100 normal students were investigated bacteriologically every month and an average of 15% to 20% were found to be carriers of hæmolytic streptococci. At a boys' school the average carrier rate for normal boys was 5% to 10%, which increased during an epidemic of tonsillitis to 43% to 54%. The average carrier rate for children resident in a home is 18%, this suggests that children are more susceptible to streptococci. A carrier of streptococci may have less resistance to this infection than the non carrier.

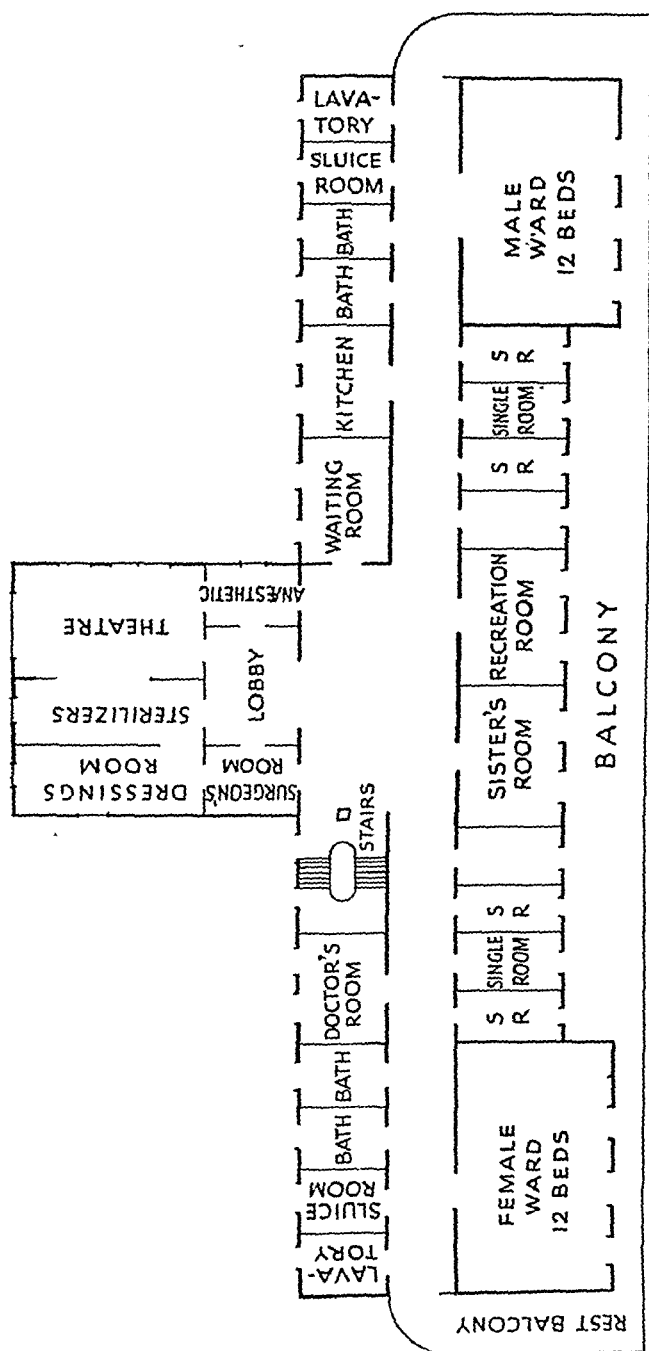


Fig. 2.
Plan of First Floor of E.N.T. Dept.
Lory Hospital, Berne (adapted).

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DISCUSSION

The PRESIDENT said that the subject had been opened in a masterly manner and gave scope for a wide and useful discussion. It was not in itself a new subject, but it was new in the means available for dealing with it, and they had had the pleasure of hearing Professor Fleming speak with authority on the use of some of the chemotherapeutic measures which were now available.

The first of the few questions he desired to ask related to the inhibitory or bactericidal effect of mucus on organisms, as to whether they were air-borne or not. He also wished to ask whether the organisms ejected during talking were as pathogenic half an hour later as when freshly issuing from the speaker's mouth. Let it be supposed that they were collected on the clothing, could they afterwards be as harmful as they would have been if projected into the respiratory passages of the recipient? It seemed to him that organisms from the speaker's pharynx, received directly in the mouth of the recipient, must have a greater pathogenic effect than those arriving indirectly.

What was the extent of effectiveness of an interceptor mask? At Horton they had introduced a mask of very simple construction, consisting of a piece of X ray film on a wire frame, which prevents organisms from being directed straight into the pharynx or nose. Years ago in Stockholm he saw masks being generally used by nurses and other members of the staff whenever they were in contact with patients. It was said that this would be difficult to impose in this country, but that was not so, it was quite practicable to get the staff to wear masks.

A valuable contribution had also been made by Mr Davis. Nurses were sometimes isolated for weeks because they were carriers, and finally they had their tonsils removed. It was possible that a person might not be a carrier one day but was so the next day. He might not be a carrier until he came into contact with a patient with some streptococcal infection. Mr Davis had spoken most usefully and to the point about the precautions which might be taken, especially before operation.

Lieut SCHINDLER (U S Army) asked how long it took with the use of the sulphathiazole snuff to clear up patients who were virulent carriers.

Major E. E. SCHARFE (R C A M C) asked the speakers if the sterilization of air was being carried out as a practical procedure in any institutions in this country. The subject of aerobiology is a very interesting one and shows possibilities. Experimental work has shown that both ultra violet radiation and the use of a propylene glycol spray have proven to be of about equal value.

Regarding diphtheria carriers we have had one case in which we used sulphathiazole powder. This case showed diphtheria organisms of the Gravis type in both throat and nasal cultures. Tonsillectomy was performed with no change in the condition. The sulphathiazole was diluted in the proportion of one third sulphathiazole and two thirds magnesium carbonate levis, and the patient snuffed this up into each nostril five to six times daily. Cultures were negative in ten days. Successive cultures over a period of ten days were still negative.

W. M. MOLLISON said that he had never felt that gargles or sprays were of any value in the treatment of throat infections and that opinion was strengthened after hearing Professor Fleming.

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At Guy's some few years ago a number of students were asked to gargle with methylene blue, and their mouths examined to see how efficient the gargling had been. In not a single case was the dye seen beyond the third molar. It had never reached the tonsil. It was quite evident that the only way in which the tonsil infection could be affected was by the sucking of lozenges or the chewing gum used by Professor Fleming.

T. B. LAYTON said that the introducers of the discussion had dealt with the parasite, he wished to speak about the host. He thought that the most important element in prevention was ventilation. He knew of two hospitals: in the maternity ward of one they were constantly being worried with precipitus of the new-born. An industrious bacteriologist attended and swabbed the noses and throats of all the workers and patients, and sooner or later a carrier was found of what was called the "causative" organisms, who was isolated, and the condition for a time disappeared. In the maternity ward of the other the problem never arose. In this ward ventilation was complete even in wartime, whereas in the other it was conspicuous by its absence. Then there was the problem of floor space which raised the question of ventilation between beds as distinct from isolation. He rather leaned towards the former. He regretted to hear that Mr. Davis had suggested a bed space of only 6 ft. In every single medical and surgical ward built in this country in future he hoped that a minimum of 10 ft. for bed space would be insisted upon, and in ear, nose and throat wards he would claim and demand that bed space of 12 ft. which was laid down as essential in the treatment of acute specific fevers.

As to isolation, it had to be remembered that the whole organization of the care of people suffering from acute specific fevers in this country depended upon a hypothesis entertained by the medical profession in the 'sixties that if one pounced upon everybody who was developing an acute infection one would shortly exterminate those diseases. It was not until the buildings had been built with a view to following out that hypothesis, and the individuals had been put into the buildings, that it was realized that it was necessary to treat them as well as to take them away from the rest of the community, and out of this there had developed the most efficient therapeutic institutions now established in this country. But so far as doing what they were originally intended to do was concerned, they had done nothing.

The isolation of individuals had done nothing to prevent the spread of infection, and it was necessary to be careful that medical views and hypotheses did not make the same mistake with regard to what might be called, not bulk reservation, but individual reservation. Isolation meant the limitation of the freedom of the individual for the benefit of the community, and unless there was no doubt at all that it was for the benefit of the community, the individual should not have his freedom limited. Complete isolation in a separate room during the invasive period of an acute infection might be beneficial to the individual, but when the period of reaction and repair set in it was no longer beneficial, though it might for a time be harmless. By the time that the period of convalescence was reached or should have been reached, however, isolation was harmful, and particularly so in the case of children.

He did not think that any child or any individual should be submitted to solitary confinement in the name of isolation for a longer period than three

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weeks, and the medical officer who committed him to solitary confinement should pause before continuing it. It was harmful to any child to have its activities limited within a narrow space of a few square feet in a ward.

Lastly there was the limitation of the institution. Under a proper organization, with a proper treatment of convalescence—which never had obtained in this country—extremely good results might follow, but even then it should not be carried on for too long. “Be it never so humble, there’s no place like home.” It was necessary to consider not merely ways of raising the resistance of the individual, but also the means whereby the individual’s resistance might be lowered. He thought that there was considerable clinical evidence to suggest that one of the most potent causes of the lowering of the resistance was mental distress or unhappiness, and that this was brought about by prolonged isolation. There was no doubt that mental influence lowered the powers of resistance of the individual to infective organisms. That was the reason why he was not prepared to accept at their face value any experiments on the nature of infectivity done on the lower animals, such as mice. He would not accept such experiments even if done on a chimpanzee, supposing that were possible.

R G MACBETH said that about six years ago, in a hospital with which he was associated, a new department was being built, and the question was gone into as carefully as possible how best to isolate patients from one another and yet to keep the cost of the building and its size within the limits determined by funds on the one hand, and acreage on the other. He had travelled round with the administrator to various places, and as a result of the studies then undertaken it was found to be advisable for the heads of patients to be 17 ft apart, and that if a building with that space was not possible there should be a glass screen between contiguous patients. The glass screens used were 7 ft 6 in in height, with a clearance below of 6 in for the cleaning, and proved very efficient. He could not give the exact figures for the cases of cross infection before and since this method was adopted, but everyone was agreed that the numbers had dropped to insignificance at the present time, and this in spite of the fact that owing to blackout it was not possible to ventilate the wards at night.

Recently a Ward-Infection Sub committee had been set up at the hospital to which problems of infection were submitted, including, among other things, the merits of masking. It had been found desirable and quite practicable to insist that the medical and nursing staffs should wear masks in the wards when making any sort of examination, or giving any sort of treatment. These masks were interleaved with cellophane. Spindle oil was used, but only in wards where there was no rubber flooring, it was somewhat dangerous from the point of view of skidding when freshly applied.

A simple experiment on air conditioning was conducted in the operating theatre. Culture dishes were left open when nobody was about at all, for a certain unit of time—an hour he thought—with the air conditioning plant not on and later with the plant in operation and the theatre in full use. In the second instance, under air-conditioning, the colonies of micro-organisms grown were only one-tenth of the number grown when air-conditioning was not applied.

On the question of ear, nose and throat patients being up and about it was

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found to be difficult to keep a patient who was ambulatory from going and playing cards with the patient who was not ambulatory. On general grounds, should recreation rooms be provided for these patients?

The PRESIDENT said that his experience during war, when there had been no ventilation at night owing to the blackout, was that there had been no increase in infections. He had the advantage of working at a hospital in which there were a large number of side rooms where patients could be isolated if they had an acute infection of the nose and throat or if they had undergone an operation, and that separation seemed to be a great advantage.

LIONEL COLLEDGE said that Mr. Davis had mentioned the cases of nurses in an obstetric ward. Apparently now the principle of eliminating carriers extended to students. He had had several students sent to him who had been prevented from carrying out their midwifery course because they were carriers, and apparently not such temporary carriers as Mr. Davis had suggested, but carriers for a period of at least three months. The only thing to do was to remove the tonsils and, as far as he knew, it had succeeded. He fancied these students must have been under the control of Professor Fleming. It was a serious thing to subject anybody to operations, however trivial, for a social as distinct from a medical purpose.

DOUGLAS GUTHRIE asked whether Professor Fleming had tried the effect of mucus other than human—that is to say, animal mucus—as an antiseptic. Some years ago a prominent member of that Section persistently advised the use of mucus, in the form of a preparation known as "mucin", so that the idea was not new. Would mucin or some such preparation of animal mucus perhaps have a better effect in the nose than an ordinary antiseptic?

RITCHIE RODGER, speaking with reference to experiments on mice with the vaccine plus sulphapyridine, said that it had been stated that the latter should never be used without a vaccine. If that was the case, would a stock vaccine be sufficient? Sulphapyridine was being prescribed and administered widely by general practitioners, and if it was stated authoritatively that the drug must always be used with the injection of vaccine they might be a little more discriminating in their employment of it.

The Journal of Laryngology and Otology

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August 1943

DEAFNESS RESULTING FROM GUNFIRE AND EXPLOSIONS

By STEPHEN SUGGIT

(Surgeon Lieutenant Commander R N V R)

GUNNERY and explosives in general can produce three clinical types of deafness firstly, middle ear deafness, secondly, a gradual high tone loss due to prolonged damage to the cochlea, and thirdly, an abrupt high tone loss due to blast concussion. Combinations of these types can occur, and sometimes one ear will show one type and the other ear of the same patient another type. The material in this paper is derived from 69 injured ears admitted as a consecutive series to a Royal Naval Hospital during a period of nine months. The audiograms were made on a Marconi Ekco acutymeter, type T F 444, in a small room adjoining a hospital ward. A deduction of 30 decibels in the hearing loss has been made for each frequency to compensate for external noise. Several examinations on normal ears have confirmed that this gives, in the conditions under which examination took place, reasonably accurate normal values for air conduction. The conditions were the same for all audiograms used in compiling these results. The audiograms shown are all air conduction graphs.

A. Middle-Ear Type

The most commonly recognized injury is a rupture of the ear drum with bleeding into the external auditory meatus. It has been noted by several observers that the margins of the perforation of the ear drum may be everted, and it has been suggested that this is caused by the suction component of the blast wave. It has been shown by Zuckerman¹⁵ that the blast wave is a single pulse of increased pressure followed by a wave of suction, and that the suction wave, though of considerably less magnitude lasts three to five times as long as the pressure component. The

Stephen Suggit

hearing loss is essentially of middle-ear type with a negative Rinne. Frequently, however, there is evidence of additional injury to the cochlea in the form of a slight high tone loss.

Figure 1 gives a typical example of this type of deafness. This man was exposed to the gunfire of a 12-pounder gun fourteen days before the first audiogram was made. Dry cotton wool had been worn in the meatus.

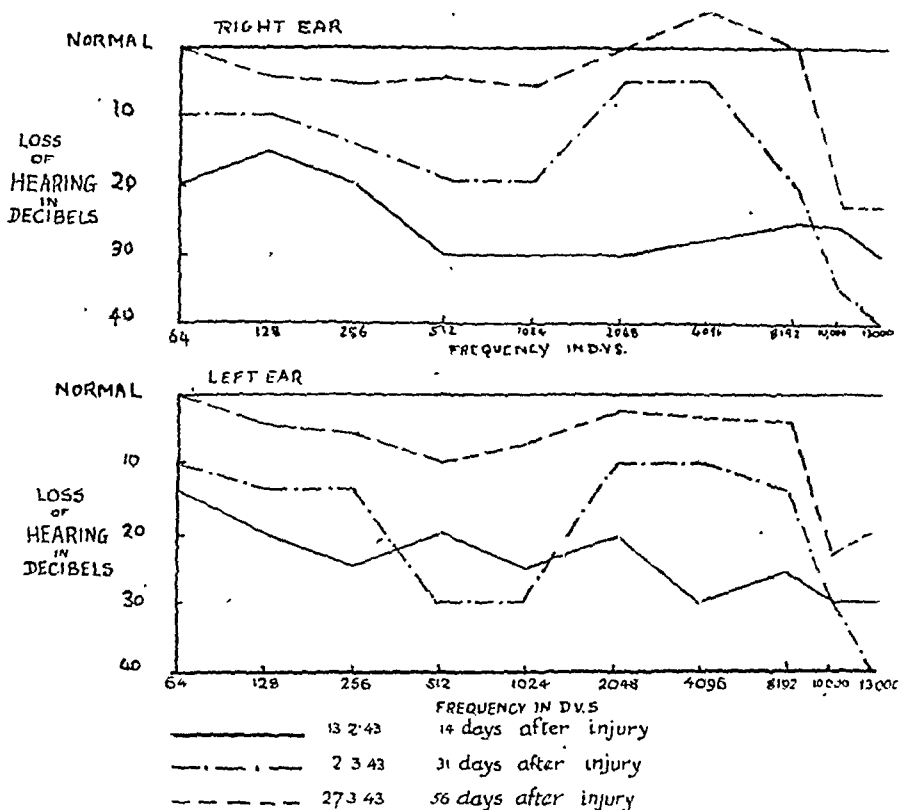


FIG. 1.

Man aged 25, blast from 12-pounder gun, 14 days prior to first audiogram

At the time when the first audiogram was made, dry blood clot was present on the right ear drum in front of the malleus. The left ear drum appeared intact. As will be seen by the subsequent audiograms, recovery was complete, except for the 8,000-13,000 frequency zone, in 56 days. This slight high tone loss indicates an additional cochlear lesion, in view of the man's age, viz. 25. This period of recovery is longer than Alexander's estimate of an average period of 25 days. Provided the middle ear does not become infected by injudicious manipulations in the external auditory meatus, this type of deafness shows complete recovery in the

Deafness Resulting from Gunfire and Explosions

vast majority of cases. However, the additional high tone loss from cochlear injury is unlikely to show any recovery.

B. Gradual High Tone Loss

Exposure to gunfire over a period of years produces a cochlear deafness with a gradually falling curve as the audiogram is read from the lower tones towards the high tones. This type of deafness is identical with occupational deafness as defined by Perlman,¹¹ "In a healthy person under 50 without history or evidence of aural disease, and whose history does not suggest intoxication from drugs, etc., or some severe constitutional disease or deafness in the family, but reveals exposure to acoustic stimuli of a nature resembling those mentioned, a high tone loss must be suspected to represent the effect of acoustic trauma." In these cases evidence of injury to the drumhead or middle ear is usually absent.

The first indication of an occupational deafness has been shown by Dickson and Ewing^{6,7} in this country in 1939 and 1941, by Bunch² in America in 1937, and Larsen⁹ in Denmark in 1939 to be a fall in hearing in the region of 4,000 cycles, the loss at first being entirely limited to a dip in the curve at this point. This clinical fact was noted by Jaehne⁸ in 1911, "*Alleinige Schädigung der Perzeption von C 4 und C 5*". This observation was made long before the advent of the audiometer. Dickson, Ewing, and Little⁶ have shown that R.A.F. personnel were found prone to high tone deafness after as little as 100 hours exposure to aeroplane noise. It appears that in the earliest cases recovery can occur, though tinnitus may persist for some time. Once the exposure to sound trauma has lasted some length of time, the hearing loss is permanent. Figure 2 shows a permanent dip at 4,000 cycles following three weeks' work at a punch press. If, however, the patient is removed from further trauma at

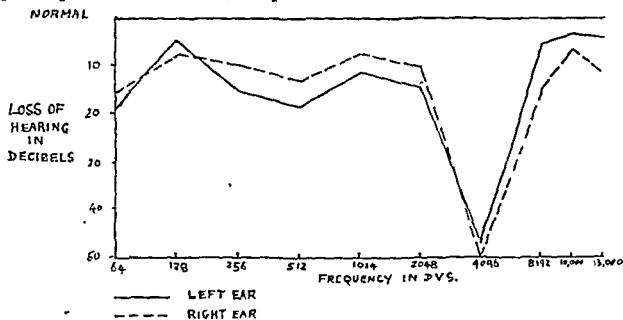


FIG 2

Man aged 19. 3 weeks working with a punch press, 3 months ago.

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this stage, the deafness does not appear to increase. There is evidence nevertheless that, if a gradual fall of the whole audiogram curve has been produced with lowering of the upper tone limit, degeneration of the cochleae continues, resulting in a premature presbycusis.

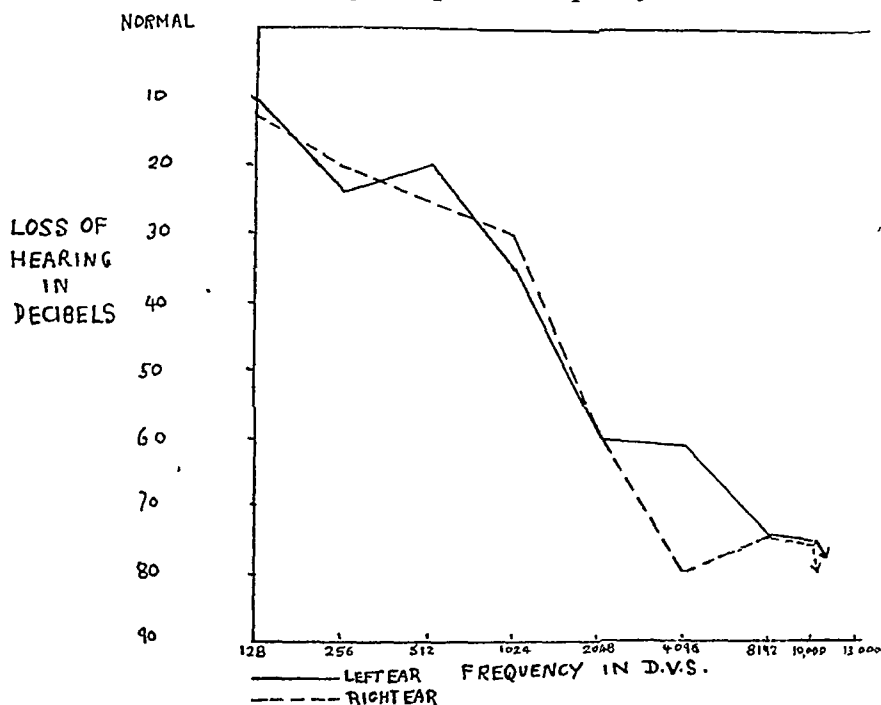


FIG. 3.

Man aged 50, a gunner for 30 years.

Figure 3 gives a typical gunner's deafness resulting from some 30 years' exposure to gunfire in a man aged 50.

Figure 4 is shown chiefly as a curiosity. This woman, aged 24, had

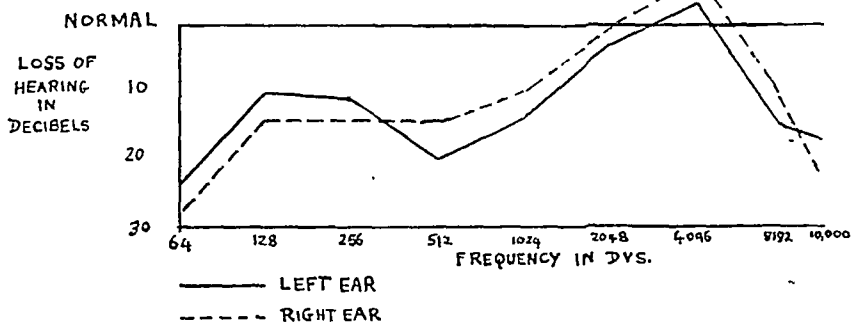


FIG. 4.

Woman aged 24. 3 years in an anti-aircraft battery.

Deafness Resulting from Gunfire and Explosions

served as an anti aircraft gunner for three years in the A T S and complained that she had difficulty in hearing in noisy surroundings. Contrary to expectation there is no hearing loss at 4,096 cycles, but a moderate loss below this frequency together with a fall in the frequencies above 4,096 cycles. The significant point in this audiogram is the high tone loss above 4,096 cycles, which is quite abnormal for a young woman of 24. It is reasonable to regard this case as an early gunnery deafness of gradual high tone loss type.

C. Abrupt High Tone Loss

As long ago as 1911, Jaehne⁸ distinguished, "die sogenannte professionelle Schwerhörigkeit und die Schwerhörigkeit nach Detonationen". As Campbell,³ Dickson,⁷ Bunch,² and Colledge⁴ have recently pointed out a high tone cochlear deafness can be produced by a single explosion such as the muzzle blast of a high powered rifle. Bunch² quotes Crowe as having defined the terms "gradual high tone loss" and "abrupt high tone loss", and comments, "This differentiation between 'abrupt' and 'gradual' cannot be carried to the extreme, but the terms are quite descriptive". The audiograms shown here give ample justification for the use of Crowe's terms to distinguish the two types of deafness. As Jaehne,⁸ Campbell³ and Colledge⁴ state, it is usual in this type of concussion deafness for the ear drum to be intact, and that rupture of the drum-head actually protects the cochlea from the full force of the blast wave and prevents the occurrence of concussion deafness. In the series of 69 ears on which this paper is based, 26 were of the concussion deafness type with abrupt high tone loss. Only two of these showed evidence of rupture of the drumhead. In addition a third ear had chronic middle ear disease, which had been present since childhood.

The audiogram of concussion deafness is quite characteristic and entirely different from that found in the two previous types described. A sudden sharp drop in hearing occurs between 1,000 and 2,000 cycles or between 2,000 and 4,000 cycles, in the severer injuries this vertical drop lies closer to the lower frequencies, in the lesser injuries further towards the higher frequencies. There may be a slight rise of the curve in the frequencies above the point at which the vertical drop occurs but this is never at all marked and is frequently absent. In three ears the vertical drop in the audiogram occurred between 500 and 1,000 cycles in eleven ears between 1,000 and 2,000 cycles, in ten ears between 2,000 and 4,000 cycles, and in two ears only at higher frequencies.

Figure 5 is the audiogram of a medical officer who became deaf in his left ear following exposure to the blast of a 4 inch gun three years previously. The left audiogram is characteristic of blast deafness. There is a slight high tone loss in the right ear, but in view of his age, nearly 38, this is probably not traumatic. He finds difficulty in hearing the spoken voice when the speaker is on his left-hand side.

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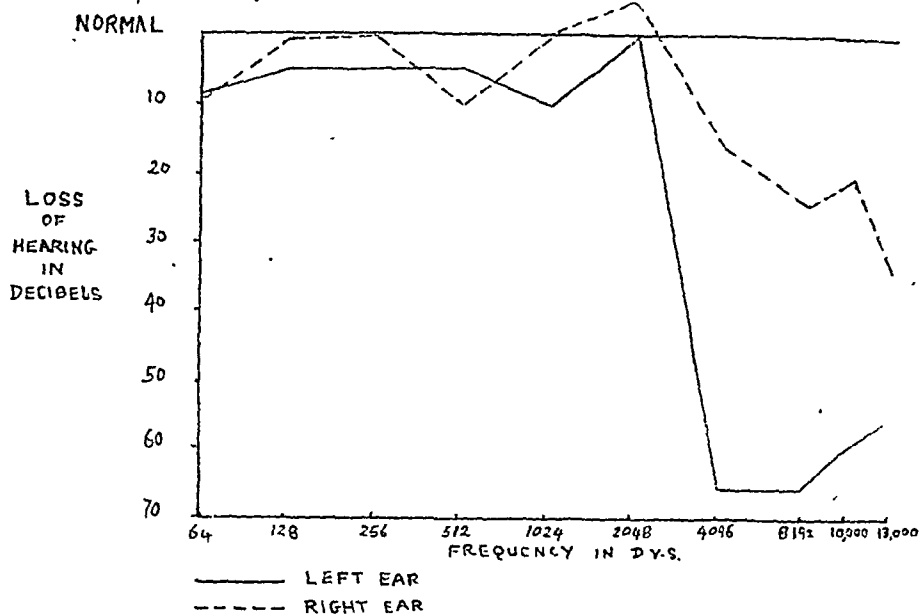


FIG. 5.

Man aged 37, blast from a 4-in. gun, 3 years ago.

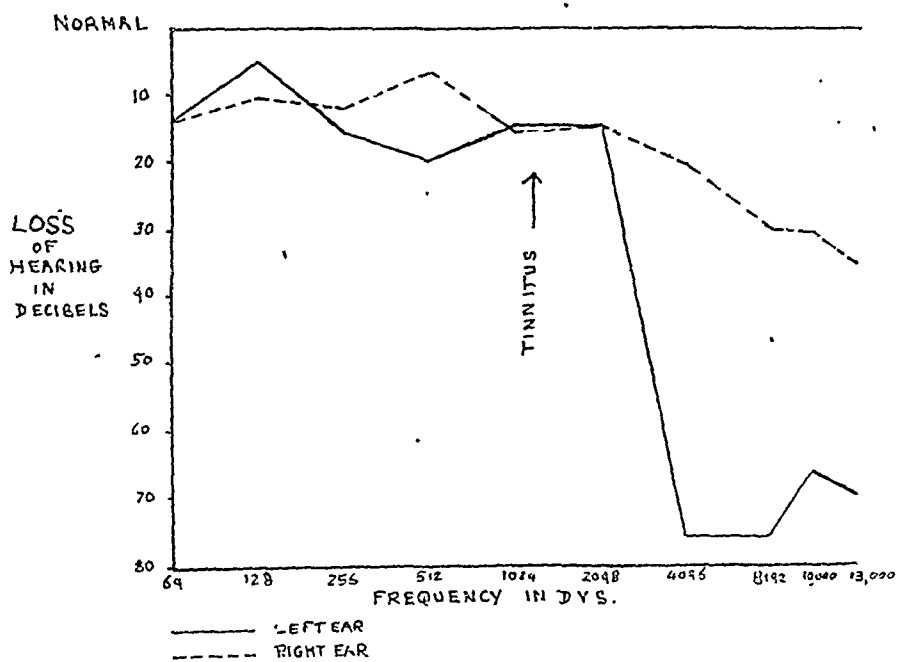


FIG. 6.

Man aged 28, blast from a 12-pounder gun, 18 months ago.

Deafness Resulting from Gunfire and Explosions

Figure 6 shows a left concussion deafness in a man of 28 following the blast of a 12-pounder gun eighteen months previously. Bone conduction in the left ear was entirely lateralized to the right ear above 2,000 cycles.

Figure 7 is the audiogram of a man aged 21, exposed three months previously to the blast of a 4-inch gun. This shows the vertical drop beginning at 1,000 cycles in the left ear, and at 2,000 cycles in the right ear.

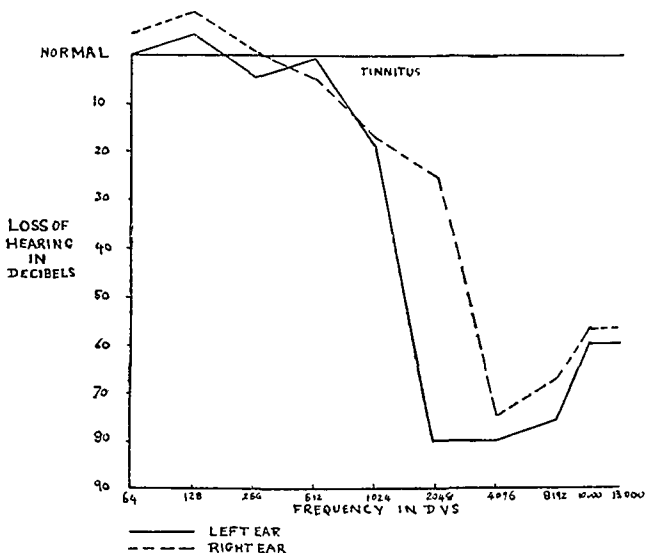


FIG 7

Man aged 21 blast from a 4 in gun 3 months ago

Figure 8 shows a bilateral concussion deafness in a man aged 42 following bomb blast over two years previously. He found conversation on the telephone difficult.

Figure 9 is the audiogram of a man aged 41. Four months previously a Verrey pistol was fired close to his head. In this case the vertical drop is between 500 and 1,000 cycles, and a moderate rise up to 8,000 cycles is present.

Figure 10 shows a bilateral concussion deafness in a man of 37, who took part in a gunnery exercise ten days previously, using dry cotton wool.

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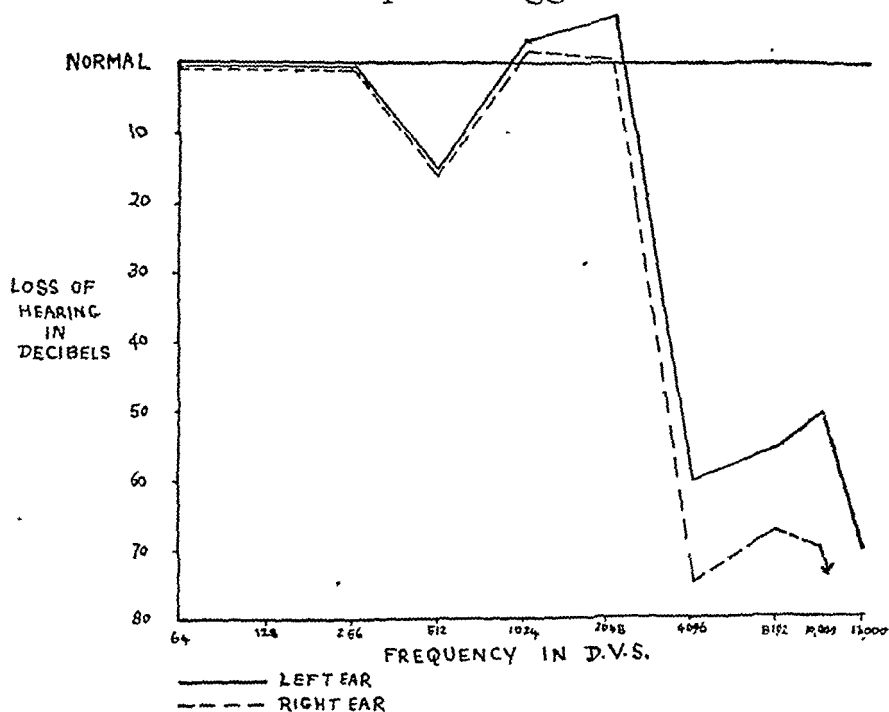


FIG. 8.

Man aged 42, blast from a bomb, 2 years 4 months ago.

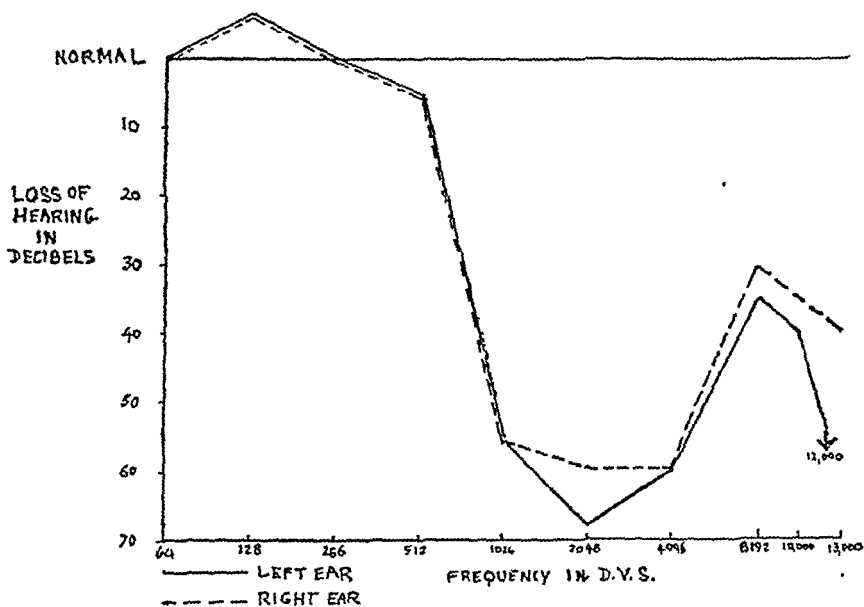


FIG. 9.

Man aged 41, Verex pistol fired close to his head, 4 months ago.

Deafness Resulting from Gunfire and Explosions

in the meatus as protection. 4-inch and 12-pounder guns were fired during the exercise. A second audiogram twenty-five days later showed no change.

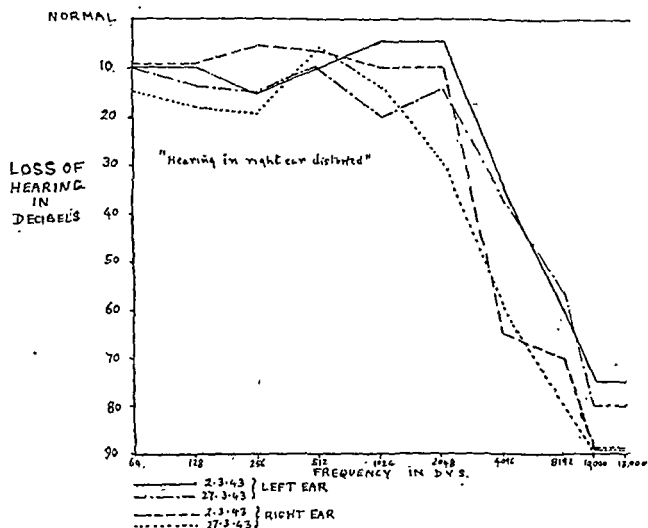


FIG. 10.

Man aged 37, blast of 4-in. and 12-pounder guns, 10 days prior to first audiogram.

Figure 11 is the audiogram of a man aged 33 who was stationed close to a 3-inch gun two years previously during the evacuation of Crete. A concussion deafness is present in the right ear.

Figure 12 is the audiogram of a woman aged 20, serving in the W.R.N.S., who complained of a left deafness following practice with a .303 rifle nine days previously. The left ear shows an abrupt fall in the audiogram at 4,000 cycles.

There was no evidence of rupture of the drumhead in this representative series shown in Figures 5 to 12. Tinnitus is frequent and occurs characteristically at approximately the same frequency as that at which the abrupt fall in the audiogram is situated. It was present in three cases of the seven illustrated; viz. Figures 6, 7 and 11, and in the latter had persisted for two years. Josephine Collier⁵ quotes Trueta's statistics stating that blast injuries produced labyrinthine irritation of short

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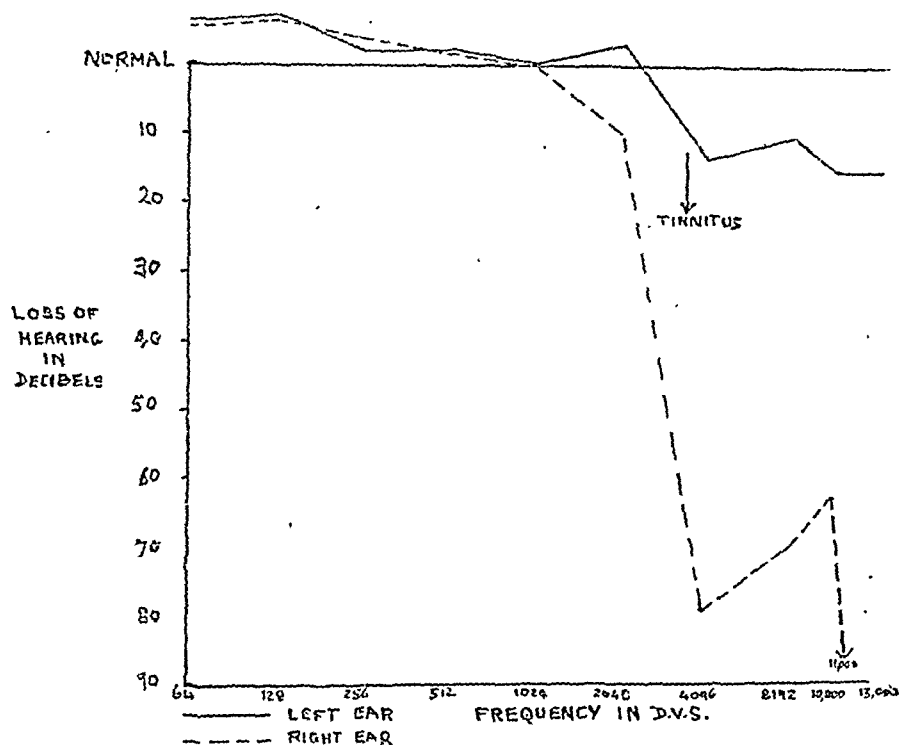


FIG. 11.

Man aged 33, blast of 3-in. gun, 2 years ago.

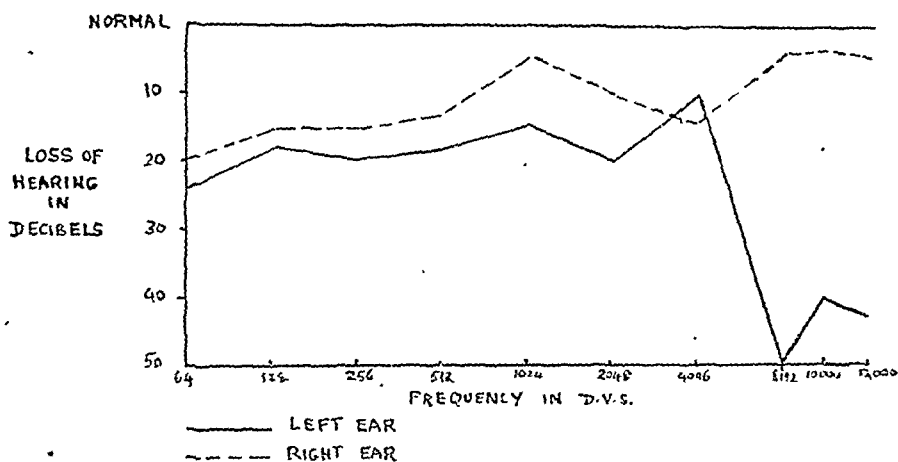


FIG. 12.

Woman aged 20, blast from .303 rifle, 9 days ago.

Deafness Resulting from Gunfire and Explosions

duration in 2 per cent of cases Only one case of the present material had any symptom of labyrinthine irritation The case, whose audiogram is shown in Figure 6, still complained of attacks of rotatory vertigo and transfrontal headache about once a week eighteen months after the injury The cold caloric test on the affected ear gave, however, a normal response

In the paper by Bunch two audiograms (Cases 3 and 5) are shown which have an abrupt high tone loss similar to the present series The first of these had had a head injury and had since been employed as a blacksmith, the second had been deaf following the firing of a single shot from a small calibre naval gun

The audiograms in Figures 5 to 12 were made at varying periods from nine days to three years after the injury These are all the same type and this strongly suggests that the deafness is immediate and does not alter to any great degree with the passage of time In the discussion of the Otological Section in the Royal Society of Medicine in 1940, Watkyn Thomas⁴⁴ considered that the high tone deafness was progressive, but Negus¹⁰ states that he himself acquired a high tone deafness in the last war, his high tone limit remaining at about 5,000 cycles, and that the deafness had not progressed It is possible that the difference between these two viewpoints arises through confusion of the gradual loss type, and the abrupt loss type of high tone deafness I do not consider that this question can be answered at all conclusively, but the evidence suggests that the gradual loss type is progressive and the abrupt loss type remains stationary

Analysis of the type of Deafness in 69 Ears

A	Middle ear deafness	18
B	Gradual high tone loss	9
C	Abrupt high tone loss	26
D	Mixed middle ear and gradual high tone loss	6
E	Mixed middle ear and abrupt high tone loss	9
F	Mixed gradual and abrupt high tone loss	1

Pathology

In the gradual loss type of high tone deafness a general degeneration of the organ of Corti occurs, and is greatest in the basal coil of the cochlea The evidence suggests that the process begins at the point in the basal coil corresponding to a frequency of 4,000 cycles

In the abrupt loss type, the immediate and severe hearing loss over a circumscribed area, and the apparent subsequent stationary condition suggest a different type of lesion in the basal coil Negus¹⁰ states, "As to the effects in producing internal ear deafness, there could not be any

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doubt that there were hæmorrhages into the labyrinth." Stenger²² in 1909 observed the results of subjecting white rats to blows on the head. He found that light trauma produced hæmorrhages in the region of the round window and basal coil of the cochlea, but not in the vestibule or semicircular canals. The hæmorrhages were more widespread when greater degrees of trauma were used. He describes the injury as "Labyrintherschütterung", or concussion of the labyrinth, as opposed to "Labyrinthverletzung", or direct injury to the labyrinth. He considers that the following mechanism takes place: a sudden rise of labyrinthine pressure occurs, which according to Barnick is directed especially to the area of the round window, and thereby causes small lesions with subsequent extravasation of blood.

Cochlear deafness is not uncommon in head injury, and Campbell²³ reports its occurrence in 16 out of 100 consecutive cases of fractured skull admitted to Toronto General Hospital. The analogy between deafness due to blast concussion and deafness due to head injury is an attractive one, but the clinical findings do not give a great deal of support to this. The audiogram in head injury gives a gradual loss rather than an abrupt loss, and "the hearing often improves during the first three to four months".²³ However, the discrepancy may be due to the difference in degree of trauma and the resulting severity of the lesion, rather than to the actual type of pathological change. It is probable that the hæmorrhages are much more circumscribed in the basal coil of the cochlea in blast concussion than in head injury.

The absence of injury to the ear drum in the majority of cases of concussion blast deafness has been commented on above. Perlman²⁴ gives the latent period of contraction of the intrinsic aural muscles as $10 \cdot 5^3$ seconds, during which the cochlea is unprotected. Thompson²⁵ in his observations on the fire of 16-in. guns, at a wave velocity of 1,500 to 1,800 m/sec., over all power of source 10^7 h.p. for 0.05 sec. at gas jet muzzle, gives the time of condensation as 10^{-11} sec., with an intensity wave of 10^7 watts/cm.² The speed of the blast wave, and the rapidity with which the pressure component of the blast wave reaches its maximum is, therefore, vastly greater than the speed at which the intrinsic aural muscles can tense the ear drum. It seems, therefore, that whether a ruptured drum results, or an injury to the cochlea with an intact ear drum, depends entirely on whether the ear drum happens to be tensed or not at the moment of impact. In practice it is found that ear injuries of all types occur more often from the smaller calibre guns than the larger. The interesting fact is not so much the numbers and variation of the ear injuries seen resulting from explosions, but the number of ears which escape any injury, but must inevitably be exposed to such trauma.

There are two possible routes by which the blast wave can reach the cochlea: one by the meatus of the external ear, and the other by direct

Deafness Resulting from Gunfire and Explosions

contact with the skull Jaehne⁸ considered that direct concussion of the side of the skull was insignificant compared with the route by the external and middle ear. The protection that the cochlea derives from rupturing of the drum and consequent diminution in the force of the wave when it reaches the cochlea, seems to support his contention, but the magnitude of the pressure component of the waves that results from explosions suggests that injury may well result by either route. Moreover a concussion blast injury of the cochlea can result even when protective material is worn in the external auditory meatus.

As to whether it is the sound or the shock wave that produces the injury, the answer is given by Thompson,¹³ "Sound waves of very great condensation may become shock waves, as a result of propagation phenomena, even if the disturbance does not initially have the abrupt form characteristic of shock."

Protection

The protection in general use in the Royal Navy is dry cotton wool plugs in the external ear. In some of the cases used for this paper cotton wool has been worn, and in others no protection has been worn. In none of the three clinical types does it appear to have made any difference to the trauma sustained. Dickson and Ewing⁷ in their investigations into the protection of air crews against aeroplane noise state, "No device is effective unless it is completely tight-fitting. Sound penetrates through minute apertures, hence the very small amount of protection given by plugs of dry cotton wool, which is somewhat harsh as well as porous and, therefore, for both reasons leaky." Somewhat greater protection is given by vaselined cotton wool and various forms of rubber plugs. However well plugged the external auditory meatus may be, the protection is limited, moreover effective plugging diminishes the ability to hear orders. If meatal plugs give only moderate protection against prolonged exposure to noise, the protection they give against a blast wave must be very little. Protection against aeroplane noise has been made more effective by the use of the high altitude flying helmet in which telephones form part of the protection.⁷ It is probable that protection of gun crews can be improved by the development of an anti flash helmet containing telephones, thereby giving both the external auditory meatus and the side of the skull some degree of protection.

I wish to thank Commander R. W. Lawrence, D.S.C., R.N. for his help and advice in gunnery matters and my assistant, Sick Berth Petty Officer W. M. Owen, for helping me with the recording of the audiograms thereby acting as an independent witness. I am indebted to Surgeon Rear-Admiral H. StC. Colson and the Medical Director-General of the Royal Navy for permission to publish this paper.

Stephen Suggit

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CLINICAL RECORD

PENETRATING SHELL WOUND OF NECK INVOLVING LARYNX

By MAJOR BRIAN REEVES R A M C

THE immediate mortality rate from shell wounds of the larynx is high and for this reason such cases are rarely seen in hospital

The author of this article takes no credit for this case but considers it worth recording, not only for the interesting recovery, but for the excellent way in which it was managed through various stages from the front line

Although the patient was an ill man when seen at the base hospital, he owes his life and rapid recovery to the forward Surgical Units

Sergeant W H , age 33 25 4 43 Patient was " tinkering with a German wireless set " when two small mortar bombs fell about three yards away

He jumped into a trench and some men of his platoon bandaged his neck with first field dressings and he was taken to a Regimental Aid Post, " coughing and spitting a lot of blood " He could not swallow

He was given an injection (? nature) at the Regimental Aid Post and was taken to the Field Ambulance Main Dressing Station

Patient remembers nothing after this until he woke up with his tracheotomy tube *in situ*

Field Ambulance Main Dressing Station 25 4 43 " Small wound lower sterno mastoid region (L) and large deep laceration in R anterior triangle ? involving trachea This appears to be an *exit* wound

General condition good Pulse 104

Casualty Clearing Station Surgical Team 25 4 43 B P 120/80 P 100 Anaesthetic Ethyl Chloride/Ether (I T *via* tracheotomy tube)

Good deal of bleeding into upper air passages Tracheotomy done, lower part isthmus of thyroid divided

Large ragged *exit* wound in R side of neck extended and explored Hyoid fractured in several places Large opening into pharynx to R of base of tongue, epiglottis injured Trimmed, and lacerated tissue removed Pharynx sutured, rest of wound left open except medial end which was sutured Sulphonamide and vaseline gauze

Smaller entrance wound L side neck lateral to thyroid cartilage upper cornu of which was fractured Trimmed and loose pieces of cartilage removed Mucosa and overlying muscles sutured Wound left widely open—Signed K B "

26 4 43 " General condition good

Attempt to pass nasal stomach tube failed

Will require tube feeding or intravenous fluids (Evacuate)—Signed K B "

Casualty Clearing Station " General condition good Tracheotomy tube blocked, but airway good *via* normal channels

Wounds inspected—both infected but draining well To be fed *via* stomach tube "

Brian Reeves

27.4.43. "Satisfactory. T. 101°. P. 96."

28.4.43. "T. 99°. P. 96."

"Fed by stomach tube.

Good natural airway but tracheotomy tube left in, in case of any developing infection and subsequent œdema."

General Hospital. 29.4.43. "General condition fair. Pyrexial. ? Small patch pneumonia right mid zone—M & B 693 started.

Still has to be fed by stomach tube. Breathes normally so tracheotomy tube removed. Wounds satisfactory and granulating.

Larynx. Wound lateral wall right vallecula. Epiglottis swollen with infiltrated blood. Arytenoids swollen left greater than right and left vocal cord is fixed. Right moves normally but voice is husky and weak."

6.5.43. "Much better. Apyrexia. M & B stopped. 38 gm. Voice improving. Stomach tube removed and is taking fairly well by mouth."

10.5.43. "Still some discharge from wound below jaw right side. Tracheotomy wound almost healed. Voice still husky but stronger.—R.S.L."

"No follow up cards available.

Could you please let me know how this larynx gets on?—R.S.L."

Base General Hospital. 16.5.43. "Temperature 99°. Pulse 92. Respiration 20. General condition good. Voice hoarse. Tracheotomy and chin wounds almost healed."

18.5.43. "Noted swelling left side of neck, painful and throbbing. T. 99°. P. 92. R. 20.

O.E. "Abscess present, left side of neck which on pressure evacuates into pharynx. Fluctuant. Other wounds healing.

Tracheotomy wound practically healed.—J.W.H.S."

19.5.43. Radiological examination.

"Fracture of hyoid. ? Sequestrum.

No foreign bodies seen.—J.J.N.D."

22.5.43. It was at this point that I was called to see the patient as he was distressed with the contents of the cervical abscess emptying into the pharynx.

He was sitting propped up in bed holding his head very rigid and following movements about the ward with his eyes only. He appeared ill.

Temperature 98°. Pulse 80. Respiration 20. Occasional spasms of cough producing purulent sputum.

Incision of the abscess was advised at once and I did not look at the larynx at that time.

The patient was taken to the theatre and the abscess incised under N20 and O2.

A large amount of pus poured out.

25.5.43 to 28.5.43. Following the operation the patient made an uninterrupted recovery. "Fomentations 4 hourly to neck."

29.5.43. Patient was well enough to walk from the ward to my room (70 yards). He was hoarse.

Indirect laryngoscopy: The epiglottis was slightly twisted anti-clockwise. There was a large swelling of the mucosa covering the left arytenoid extending up into the left ary-epiglottic and ventricular folds. This swelling was pushing the epiglottis round to the right. The swelling obscured the left cord.

Clinical Record

The right cord was normal in appearance and movement

After cocaineizing the larynx the left cord was seen to be fixed in abduction—there was no movement on phonation whatsoever

There was no sign of any wound in the right vallecula, the right glosso epiglottic fold or the base of tongue

30 5 43 I was again asked to see the patient as regards disposal

Physical examination The left vocal cord remained immobile but the swelling over the left arytenoid was less He was hoarse

16 6 43 Voice improving Patient says he feels fit except for slight shortness of breath on walking fast

The larynx appeared as on 29 5 43 except that the *right cord* was crossing the mid line on phonation

20 6 43 Voice normal

Both cords now move fully

The left cord is still obscured in the abducted position by swelling

23 6 43 X-ray chest "Both hilar shadows dense with appearances of some chronic bronchitis but no appearances of lung abscess—J J N D"

27 6 43 Epiglottis remains twisted in anti clockwise direction

Both cords move fully

The cartilages of Santorini and Wrisberg appear fixed in the *outer* aspect of the ary epiglottic fold

Voice is normal and patient states he feels 'A1'

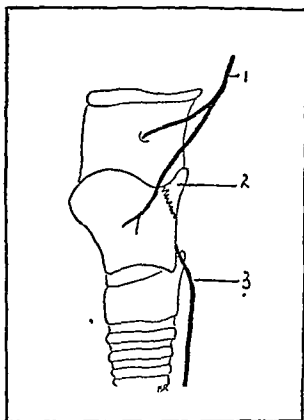


FIG 1

Outer Aspect Left side Larynx

- 1 Superior laryngeal nerve
- 2 Superior cornu of thyroid cartilage fractured by missile entering larynx
- 3 Recurrent laryngeal nerve

Brian Reeves

Pathological Anatomy

The shell fragment appears to have taken an upward and outward path, entering the left side of the neck, at the junction of the upper two-thirds and lower third of the anterior border of the left sternomastoid muscle. The exit wound being irregular and approximately 1 cm. below the base of the right mandible (see photograph).

The fragment fractured the left superior cornu of thyroid cartilage passing between the external branch of the left superior laryngeal nerve and the left recurrent laryngeal nerve. The damage to these nerves would appear to be concussion as recovery is complete (see Fig. 1).

In the larynx the left ary-epiglottic fold and epiglottis were contused.

The fragment left the pharynx by tearing the "lateral wall of right vallecula" and the "right base of tongue". (This wound was sutured.)

The hyoid bone must have been fractured at this stage.

The rapid recovery of movement of the left vocal cord is interesting for on 16.6.43 the left vocal cord was seen by me to be fixed in abduction.

On 20.6.43 the movement of the left vocal cord was unimpaired.

On 27.6.43 the only abnormality noticed on indirect laryngoscopy was fixation of the two cartilages in the left ary-epiglottic fold, together with a slight twist of the epiglottis in an anti-clockwise direction.

Summary

1. A case of penetrating shell wound of neck is recorded.
2. Management and treatment is recorded verbatim.
3. Rapid healing of pharyngeal wall is noted together with restoration of function of larynx.
4. The pathological anatomy is discussed.

I wish to thank the Officer Commanding a British General Hospital for permission to publish this case.



FIG 2

Photograph taken 28 6 43

Scar of entry wound over lower aspect of left sterno mastoid muscle.
Scar of exit wound over right anterior triangle immediately below
base of inferior maxilla
Arrow denotes line of missile
Well healed tracheotomy scar

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY AND SECTION OF OTOTOLOGY

Chairman—V E NEGUS F R C S (President of the Section of Laryngology)

SUMMER MEETING

Friday, June 4th, 1943

AFTERNOON SESSION

Ten Years' Experience of the Displacement Treatment

BEDFORD RUSSELL

It is now some twelve years since Dr' Proetz read us a paper introducing his displacement method as a help in the diagnosis and treatment of nasal disorders. The method has been used both in diagnosis and treatment at St Bartholomew's Hospital for more than ten years. Progress has been made in the interpretation of contrast skiagrams and familiarity has also been acquired in the use of the method by way of treatment.

Principle of the Method—Air is withdrawn from the sinuses by lowering the pressure in the nasal passages being replaced by fluid previously introduced into the nose.

Technique for Displacement Treatment—The nose is sprayed with a solution containing 4 per cent of cocaine hydrochloride, 1 per cent of ephedrine hydrochloride, and 0.5 per cent of potassium sulphate in water—a few puffs up either nostril from a fine spray being employed. After two minutes the spraying is repeated. This not only benumbs the mucosa somewhat, but opens up the passages so as to facilitate the arrival of therapeutic fluids at the ostia.

The patient then lies supine with the head extended over the back of the couch so that the chin is vertically over the external auditory meatus, and is told to breathe slowly and audibly through the mouth. Two drachms of the chosen fluid are then introduced into the nose. One nostril is now occluded, and the nozzle of a modified breast pump introduced firmly into the other nostril, the bulb being squeezed flat beforehand. Next the patient whispers the word "lick" rapidly, while the bulb is allowed to expand gently. After suction has been maintained for a second or less, the bulb is gently compressed again, the other nostril being synchronously unblocked. (At no time must positive pressure be allowed to arise in the nasal passages.) The suction is repeated several times on either side, after which the patient rolls over on to the face, the treatment being thus completed. It is important that the suction

Societies' Proceedings

should not be applied suddenly, particularly in a patient suffering with headaches ; and a stiff bulb should not be employed. This bulb is soft, and cannot develop a negative pressure of more than 60 mm. of mercury. The bulb need never be expanded completely during suction.

In normal subjects all the fluid enters the sinuses ; so that none escapes when the patient sits up, a few drops beginning to appear in about half a minute. In some cases of headache, in which there is considerable cedema of the mucosa lining the ostia, the fluid may take several hours to reappear after the first treatment. In cases which are going to respond favourably, the solution escapes more rapidly with each treatment, which is usually done at four-day intervals.

In the obstructive stage of a cold the mucosa is so swollen that the nose will only take a few c.c. of solution, and when suction is applied the fluid may rise in the tube. In this case the obstructing finger should be removed from the other nostril and the fluid allowed slowly to sink again into the nose. If the whole process is repeated after ten minutes, it will be found that more fluid can then be introduced.

The instruction to breathe *audibly* through the mouth is given lest the patient, while listening to instructions, may inadvertently close his lips, with consequent inhalation of fluid. Furthermore, there is a tendency for the patient to relax the hyperextension of the head required to prevent fluid spilling from the nose into the larynx.

It is no more easy to define accurately the indications for displacement treatment than those for the use of collunaria ; but any condition that might be expected to respond to the use of Coll. Alk. preceded by a vaso-constricting spray will probably respond more quickly to displacement with ephedrine and saline.

Area of Mucosa Involved.—We have no satisfactory method of measuring the extent of the mucosa of the upper respiratory tract, and we do not know therefore what proportion of the area is employed in lining the sinuses. It will be conceded that lotions sniffed up the nose are unlikely even under normal conditions to find their way into many of the sinuses ; and when the ostia are blocked by cedema of the mucosa it is certain that the lotion does not enter them by being sniffed up.

In a normal nose, the displacement method permits the entry of fluids into the sphenoids and posterior ethmoids always, the antra usually, and the frontals occasionally (slides 1 and 2). Under pathological conditions entry may be prevented by blocking of the ostia, and entry is assisted by a preliminary spraying of the nose with a vaso-constricting solution. If a sinus contains some air, it is usually possible to replace part of it by fluid. It will be evident, then, that a larger area of mucosa is brought into contact with therapeutic fluids by this means than by spraying and sniffing.

Sinus-block.—Inflammation and swelling of the sinus mucosa may exist without producing symptoms, but swelling of the mucosa lining the ostia introduces a mechanical factor of great importance in that it immediately permits the development of "sinus-block", which leads to a difference between the pressure in a sinus and that in the nasal passages. If the sinus pressure is



SLIDE 1
Normal filling of antra



SLIDE 2
Normal filling of sphenoids



SLIDE 3
Normal filling of ethmoids and sphenoids



SLIDE 4

Retention of lipiodol after 7 days (normally eliminated in about 36 hours)



SLIDE 5

Oil shadow lifted away from sphenoidal walls by swelling of mucosa
Taken just after a black-out



SLIDE 6
Normal thinness of mucosa six days later

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raised, headache may occur and septic absorption is facilitated, if it is lowered, a vacuum pain may arise

Theory of Action—It is not uncommon to observe benefit merely from the snuffing of Coll. Alk., one effect of which is to shrink swollen mucosa by causing exosmosis because of its hypertonicity. Everyone has from time to time met even with dramatic improvement in symptoms, following the undoing of a vicious cycle by this simple therapy. It is reasonable to expect that relief should occur more frequently when a larger area of morbid mucosa is exposed to the action of therapeutic agent, especially if it can be shown that the area taken in includes the *mucosa lining the ostia* of the sinuses. The displacement fluid recommended by Proetz—a slightly hypertonic solution of ephedrine hydrochloride in saline—helps to shrink swollen mucosa by causing exosmosis apart altogether from the vaso constricting effect of the alkaloid. It has been held by some that ephedrine displacement is no more effective than an ephedrine spray, because the spray should reach the mucosa adjacent to the ostia, shrinking it so that the ostia will open, and there must indeed occur numerous cases in which the sinuses can be ventilated by the help of sprays alone. But it is customary to reserve displacement for those cases in which the patient does *not* so obtain relief, and the superiority of the results by displacement would appear to depend upon the fact that when the pressure in the nasal passages is lowered, air leaves the sinuses, and in the act of doing so opens the ostia. The ephedrine solution waiting near the ostium is in a position to take advantage of this opening, indeed, when atmospheric pressure is restored, the fluid is forced through the ostium, exerting its vaso-constriction upon the small bottle neck of mucosa wherein the effect of swelling has been crucial.

The treatment is in certain cases followed by a feeling of malaise, beginning about an hour afterwards and lasting for two or three hours, but a similar response may occur if $1\frac{1}{2}$ per cent saline is used without ephedrine. This response suggests the effect of a vaccine, and if an interval of four days is allowed between displacements it will usually be found that the patient gradually becomes immune to the treatment, so that it is ultimately well tolerated at more frequent intervals.

Initial Intolerance—In a very small number of cases—presumably in patients who have become unusually sensitive to the toxins of their infecting organisms, there is an unfavourable response. One male patient, aged 46, obviously suffering from toxic absorption, felt extremely ill after treatment upon two occasions separated by three weeks. Several years later a female patient, aged 54, collapsed half an hour after the treatment. Three weeks afterwards the treatment was repeated, a $1\frac{1}{2}$ per cent sodium chloride solution being used without the addition of ephedrine, she collapsed again in the same way—which indicated that absorption of local toxins rather than of ephedrine might well be the reason. The treatment was then gradually worked up, beginning with the mere instillation of saline into the nose without the use of suction, with the addition later of ephedrine. Finally she was able to tolerate daily displacements with ephedrine and saline, with advantage.

The occurrence of such an untoward response is rare, and is evidence of the importance of the infection to the given patient. We have all met patients who are unbelievably debilitated by what would appear to be ordinary colds.

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Postural Intolerance.—Another type of response likely to discourage further investigation is dizziness, perhaps even vertigo with vomiting, occurring immediately after the treatment, due to intolerance of the necessary position and movements. The rarity of this symptom in children and its relative frequency in long-standing cases of sinus trouble give it a diagnostic value comparable with that of the symptoms complained of by such patients upon bending forward.

This postural dizziness may usually be overcome by making use of the lateral position described by Parkinson.⁸ Again, it will occasionally be found that the patient cannot tolerate the left lateral position, and *vice versa*, it is rare to find that neither lateral position is tolerated. After a few treatments with saline and ephedrine the giddiness is found commonly to disappear, the labyrinthine factor having been maintained apparently by impairment of lymphatic circulation in congested posterior sinuses.

Displacements as Adjuvant to Other Treatment.—Displacement may be used as adjuvant to other forms of treatment. Patients in whom short-wave diathermy upon the sinuses leads to distress can often tolerate this treatment if an ephedrine displacement is done half an hour before. The parenteral administration of vaccines, too, is in some cases tolerated better if regular ephedrine displacement is carried out during the course, presumably because it helps to overcome the turgescence associated with a focal response.

Displacement is of service as a prelude to operation; either as a course of some days or weeks with a view to decongesting the mucosa and rendering inflammation less acute; or e.g. with 1/1,000 adrenalin immediately before operation under the anæsthetic, to diminish bleeding. It is of service in post-operative treatment—either a few days after nasal operation with a view to hastening the restoration of the nasal airway and the relief of symptoms associated with congestion about the ostia of the sinuses or, later on, with a view to assisting the voiding of crusts.

The possibility of risk attending its post-operative use will at once spring to mind. Experience is now extensive and confirms that of the originator of the method, who is here quoted: "Some concern was felt at first with regard to the possibility of contaminating the Eustachian tube with secretions from the nose. This proved to be groundless, however, as no solution has ever been found in radiograms to have penetrated the middle ears or even the tubes. The reason for this is obvious: the pharyngeal end of the tube is cartilaginous and is normally collapsed. Even the patent osseous portion of the tube is relatively long and narrow, so that it is impossible for any air to escape from the middle ear when the vacuum is applied. As this is essential for the introduction of fluid, no penetration occurs. No case of infection of the middle ear as a result of this procedure has ever come to my notice" (Proetz, 1931).

This argument does not entirely cover the ground, for it is possible in some cases to cause retraction of the tympanic membranes by lowering the intranasal pressure, in the erect position. I am convinced that it is possible in rare instances to introduce watery solutions into the middle ear by displacement. Some of us will recall the case shown here, of a man, possessed apparently of Eustachian tubes of abnormal calibre and with lax tympanic membranes, in whom there were regular excursions of both membranes synchronizing with the

movements of respiration In such a subject one would certainly expect to be able to introduce fluid into the tympanum I recall also a publication of cases of otitis media following the use of a " duck " nasal douche, in which the position employed (not the displacement position) seemed to have permitted air to escape from the tympanum and a little thick secretion to enter it, probably during an involuntary deglutition

Experience now covers some thousands of cases subjected to displacements with lipidol or with therapeutic solutions, and this has not occasioned harm to the ear

Displacement in Acute Conditions—In this connection, here is another quotation from Proetz (1931), p 77 " It occurred to me that there might be danger of carrying infected fluids into sterile sinuses during treatment, and for that reason I have never employed displacement during the vascular stage of acute inflammation I do not know of a single instance in which infection has been spread " At the outset I naturally observed the same precautions, although of the opinion that infection inevitably spreads rapidly to all the sinuses, and by lymphatics rather than by gaining entrance to the ostia The distress of almost complete nasal obstruction in the early stages of influenza in 1932, however, led me to make personal experience of the risk of displacement at this stage the treatment was followed by nothing but profound relief of headache and nasal obstruction, and was repeated four-hourly, with benign results Since then, acuteness of infection has not been regarded as a contra indication It has been found possible, upon occasion, to abort an otitis media which appeared certain to suppurate, by a timely displacement As air, if present, does not usually leave the tympanum, the relief would appear to depend on diminution of congestion in the tubal lymphatics

Tympanic Displacement via the External Auditory Meatus—In many cases, both of acute and chronic otitis media, I have used displacement as a means of introducing therapeutic solutions of many kinds, including a 10 per cent solution of sulphacetamide, into the tympanum through perforations of recent or remote origin, with results most gratifying to the patient, and without unpleasant sequelae The cases in which the most obvious relief is afforded are those in which the capacity of the cilia is probably overtried by the viscosity of the secretions The calibre of the meatus naturally calls for some modification in apparatus a Siegle's speculum is the most convenient implement, and permits of inspection of the escape of bubbles followed by the entry of the fluid

Solutions other than Ephedrine and Saline—It has naturally occurred to many observers to try the effect of solutions other than ephedrine and saline introduced into the sinuses Bile salts have been tried, with a view to facilitating ciliary elimination by lowering surface tension—with inappreciable results so far The use of liquid paraffin relieves headaches in some patients in whom ephedrine and saline does not, probably because lubrication helps the cilia in the expulsion of viscid secretions The local exhibition of sulphacetamide and similar agents in isotonic solutions has been tried by displacement in a small number of cases without ill result In some cases there are good results, which may of course depend upon ingestion of the drug upon its escape from the sinuses, but there is reason to think that in some cases the local effect is helpful Ten years ago, bacterial suspensions were introduced by displacement,

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but the responses, even to very high dilutions, were sometimes rather alarming. Violent reactions, and indeed some of the untoward reactions which may follow the parenteral administration of vaccines, may be due to alterations in the antigens caused by the methods commonly used to kill the organisms; and recent experiences in the use of the "undenatured" antigens of Krueger, following the work of Gundrum⁶ and Semenov, Kracaw,⁷ and Hosmer,⁶ have been satisfactory in this respect. Gundrum and Semenov published in 1940 a report upon 800 cases treated by displacements over a period of five years. They found good results in 58 per cent. of cases of sinusitis when ephedrine or neo-synephrin were employed; and in 71 per cent., when undenatured bacterial antigens were used. They also introduced allergens by this means, but observed a much smaller percentage of success than with vaccines.

By displacement certain conditions not usually attributed to sinus trouble are found to be relieved. Intractable headache of types usually ascribed to hyperpiesia, neurasthenia, errors of refraction, pituitary swellings and migraine have on occasion been found to yield rapidly to displacement with ephedrine and saline, and to have derived presumably therefore from sinus disorders. These headaches seem for the most part to be caused by retained secretion, by vacuum in the sinuses, or by turgescence of the mucosa. An indication as to the nasal origin of a headache may be obtained by lowering the intranasal pressure by means of a suction bulb, which will often reproduce the pain complained of.

Certain Eye Troubles.—It is a common experience to hear a patient voluntarily declare that he "sees better" after a few treatments. To interpret this it is necessary to take into account the important experimental work of Le Gros Clark,¹ who studied the paths of absorption of dyes instilled into the nasal passages of rabbits. The deeper tissues of the orbit were stained an hour after the dye was put into the nose; presumably toxins follow similar paths. It is possible, therefore, that the patient might more accurately put it that he "can move the eyes with less muscular effort", owing to the escape of the oedema from the orbital periosteum following the opening of the ostia of ethmoidal cells which were previously blocked and from which the cedema had derived. A measurable improvement in vision is occasionally met. A man was referred from the Eye Department who complained of sudden blindness, total in one eye and subtotal in the other. Fourteen hours after an ephedrine displacement he was able to read with the worse eye with the help of a lens. Light may be thrown upon such cases as this by an experience previously recorded¹² in which headache with temporary blindness could be induced at will by syringing the right posterior ethmoidal cell of a male patient 42 years of age in whom several cells had been opened intranasally a few months before. It is supposed that the optic nerve in this patient lay in unusually close relationship with the posterior ethmoidal cell, perhaps without the intervention of bone.

Headaches Regarded as Unrelated to Sinus Trouble.—*Migraine.*—Though migraine is not usually regarded as coming within the scope of rhinology, an extended experience of the use of displacement gives some support to Sluder's contention¹¹ that the sphenoid is concerned in its production. Sluder held that sphenoiditis was the causative lesion. It is possible to demonstrate by lipiodol introduced into the sphenoids, first during a pain-free interval, and

secondly during an attack of right sided migraine developing a couple of days later, that an urticaria like swelling of the lining of the right sphenoid can occur between the taking of the first and second pictures, and the evidence of these and of many other such skiagrams supports Sluder's location of the *production* of the pain, but they are in favour of the general belief that many migraines are of allergic origin, rather than inflammatory as he suggested. Cases of migraine not infrequently improve during regular ephedrine displacement treatment. On the other hand (slides 3 and 4), these pictures of lipiodol shadows in a case of a right-sided migraine show a delay of seven days in the elimination of the lipiodol, instead of the 72 hours which Proetz regarded as the limit in normal cases, and support the view that infection plays a part in some cases, as sluggish ciliary elimination is often associated with inflammation. This patient, who suffered from frequent severe migraine for 17 years and who could not eat pork or lobsters, has now been free of migraine for 18 months and can eat any kind of food, probably owing to the improvement in liver function which followed improvement in nasal drainage.

Allergy—Some rhinologists experience no difficulty in dividing up their cases into allergic and non-allergic categories, the criteria of allergy being an excess of eosinophils in the nasal secretion, pallor and sudden turgidity of the mucosa with sneezing. But the eosinophilia may be variable. I recall a case in which there was an eosinophilia of 67 per cent. on one occasion, and no excess on several other occasions. Moreover, sudden turgidity of the mucosa may go hand in hand with infection, as shown by the case from which these slides, taken by Dr J. J. Craig, were prepared. The patient suffered from "black-outs", during which the sphenoidal mucosa swelled greatly. The linings of these cells were removed while they happened to be swollen, and it was found that the gland tubules in the submucosa were crammed with bacteria, the smaller vessels containing pus cells (slides 5 and 6).

Again, allergy may be associated with striking redness rather than pallor of the mucosa, as occurred in the following case of prostrating headache in a man of 50 years of age. (Omitted for brevity).

Allergy with Inflammation—If allergy occurs¹⁵ in a mucosa which has at some previous period been damaged by infection, an infinite gradation of cases may be expected, ranging from the purely inflammatory to the purely allergic, the gradations being determined by the degree to which allergy has replaced inflammation with lapse of time.

Displacement with sympatho mimetic drugs like ephedrine might be expected to help chiefly in cases in which allergy preponderates. The relief afforded in the next two cases seems to have depended upon the undoing of a mechanical interference with drainage. Male, aged 51, complaining for some weeks of pain, referred to the right eyeball. The right sphenoid refused to accept lipiodol. Displacements with ephedrine led to the escape of a large blob of thick yellow pus from the nose, with immediate relief.

Male, aged 69, suffering with paroxysmal pain referred to the back of the right eyeball, with lacrimation and anosmia which resisted ordinary palliative treatment. Ephedrine displacement treatment was followed by an escape of orange coloured pus, with immediate relief from pain, and return of sense of smell.

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Age of Patient.—Displacement treatment is more efficacious in young subjects than in adults, its most successful application being in cases of stuffy febrile colds, often cases which have persisted in spite of the removal of tonsils and adenoids.

Children in this condition usually improve very rapidly by means of such treatment, and displacement probably finds its widest application in such cases which are otherwise likely to become chronic.

Asthma.—Ephedrine displacement is usually of great help in treatment of the vicious cycle which obtains in the nasal passages of children with asthma, by initiating a benign cycle—of better ventilation—less oedema—less secretion. Favourable reports have been made by Crooks³ and Birdsall¹⁴ in such cases. See also Russell (1939). In adults the results are less satisfactory—probably because the accessory sinuses are often occupied by polyps to the exclusion of air, so that no solution can be introduced; but temporary relief is often afforded by displacement.

Hay Fever.—Displacement has frequently been tried in cases of hay fever, but without success.

Further Indications. Retained Secretion in the Sinuses.—An established indication for displacement is retention of secretion in the antrum or other sinuses. Cases in which antral puncture would formerly have been performed will very often yield to this treatment. In a stubborn case it may be necessary to repeat the replacement several times within an hour, with the production of an increasing amount of secretion after each performance. This can be repeated daily until the inflammation clears up—a procedure more easily tolerated by patient and surgeon than is multiple puncture. The antrum is mentioned first because it is the sinus most often washed out; but with the exception of the frontals, it will often be found that an empyema or a mucocele of any sinus can be coaxed into discharging by displacements.

It is customary that indications for any treatment should be based upon physical signs. But rhinological opinions upon the condition of a given nose may vary widely; one has seen the nose of a patient suffering from headaches, asthma, and rheumatism pronounced free from sinusitis upon the grounds that no pus was visible in the nasal passages, but in whom the sinuses were found at operation to contain polypi with streptococcus pyogenes in their interior. Relief from the headaches and asthma followed operation. In the absence, then, of universally accepted standards of diagnosis, physical signs cannot be laid down as the sole indications. It might be possible for standards of nasal symptoms to be agreed upon, were it not that there are numerous disorders of the sinuses which can exist without purely nasal symptoms, or which produce symptoms and signs which are common to many disorders.

The treatment has been of service in certain groups of symptoms, prominent among which are headaches, eyeball pain, difficulty in focusing, dizziness and giddiness.

When it is considered how the affective state of some patients is influenced by the above complaints, it should not be a matter of surprise that this treatment should often afford relief in the conditions included by Guye in the term "aprosia", by which he meant depression of the higher cerebral functions such as attention, concentration, judgment and restraint. This is often met

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in patients with chronic sinusitis. It is but a short step from aprosexia to mental disorder, and such cases have been benefited by replacement treatment. Difficulty in focusing, without the existence of detectable ophthalmic defect, is not infrequent in chronic sinusitis, and requires elucidation. The following case illustrates this. Difficulty in focusing, unrelieved by glasses, persisted for over two years in the case of a senior medical colleague, to the despair of his eye doctor. Immediate relief, with tolerance of glasses previously rejected, followed the escape of pus from an anterior ethmoidal cell.

Sore Throats—The occurrence of otherwise intractable sore throats in which the complaint is of an ache rather than pain on swallowing is an indication for displacement treatment. The cause of this symptom may be posterior sinusitis with peri-lymphangitic inflammation in the pharyngeal submucosa.

Conclusions—Prolonged experience of the displacement method in treatment supports the claims of the originator, and has opened up new avenues of research. I wish to thank Dr F A Pickworth for the trouble he has taken in reporting upon biopsies in certain of these cases.

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Fragmentation of Radiopaque in the Diagnosis of Sinusitis or the Snow Storm Effect.

W. STIRK ADAMS

IN the course of routine X-ray examination of the accessory nasal sinuses of patients at Rubery Mental Hospital, during the past year, using a contrast medium introduced by the Proetz air displacement method, an unusual appearance has been observed on two occasions, where fragmentation of the radiopaque, or the snowflake effect, has been seen in a nasal sinus.

The first example was met with in a man aged 58 years. The radiographer reported that the initial fillings of most of the accessory nasal sinuses were good, though only a minute quantity entered his left antrum. In the statim films there was no suggestion of the snowflake appearance, but in the 24-hour film, fragmentation of the lipiodol had appeared in the left antrum. In the 76-hour film the appearance persisted, but its position had changed. It was now in the upper anterior region of the maxillary antrum, while the lower part of the antrum was filled by a large faint shadow, presumably due to allergic swelling of the membrane. At operation a thickened fibrous membrane was present in the antrum, while in its cavity about two drachms of tenacious mucopus were found. On culture this grew streptococcus viridans and other streptococci. The patient made a good recovery. Although he had been mentally ill for the preceding four years he was discharged from hospital recovered, and has remained well.

The second example was in a woman aged 55 years. Examination by displacement X-ray showed adequate filling by radiopaque in both sphenoids and the left ethmoid. There was poor filling of the right posterior ethmoid, little in the right antrum, and none in the left. In the 24-hour film fragmentation of radiopaque was present in the central region of a large right sphenoid. In the lateral view this was seen to be in the posterior loculus of the sphenoid. In the 76-hour films the appearance persisted, though the shape was somewhat altered.

At operation the antral mucosa was found to be thickened and fibrous. It presented oedematous polypi on its free surface, and a small quantity of purulent exudate was removed from the cavity. The sphenoidal sinus was found to have a polypoid lining membrane which was also removed. It was noted that the bony cortex of the sphenoidal sinus was softened. Bacteriological examination of the bony anterior wall of the right sphenoid revealed staphylococcus albus, streptococcus viridans, and haemolytic streptococci while polypoid membrane from the right sphenoidal sinus contained micrococcus catarrhalis in addition.

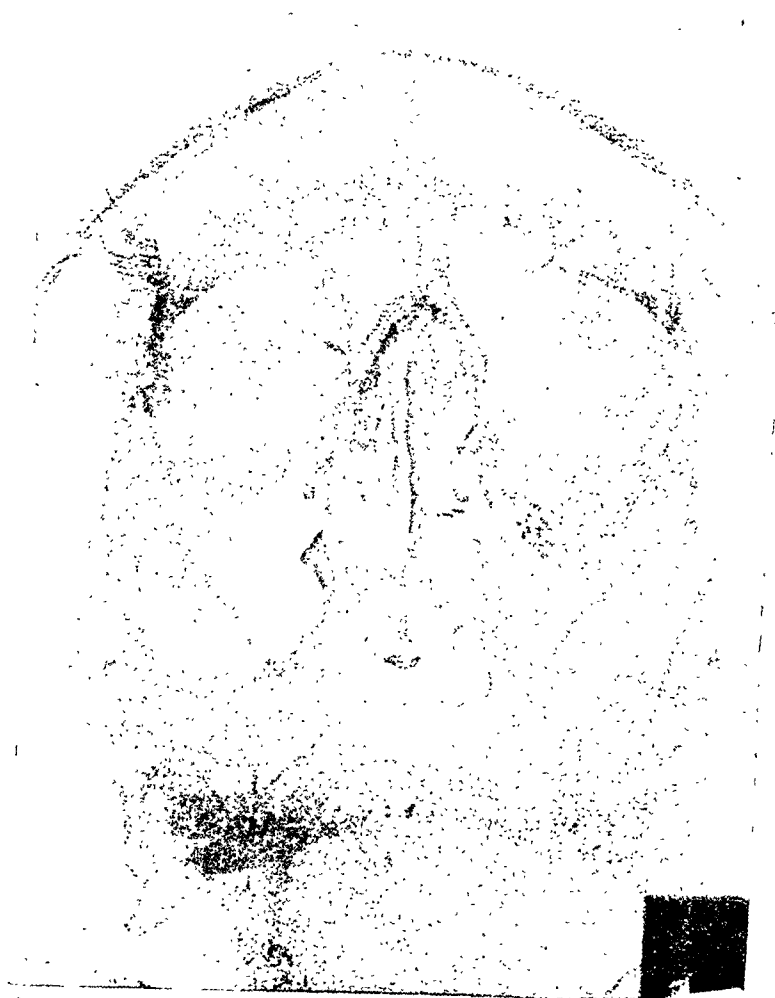
A third example of this condition was discovered in May 1943, in a lady aged 32. This patient had suffered from attacks which she described as complete visual black-outs without loss of consciousness, at intervals during the previous 15 years.

These attacks may last only a few minutes or several hours, and there is no loss of consciousness with them. The headaches have varied in their location,

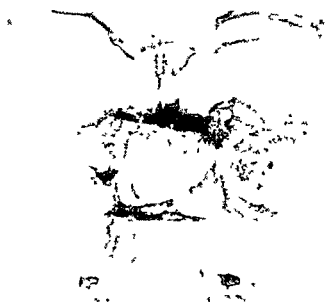
24 hrs



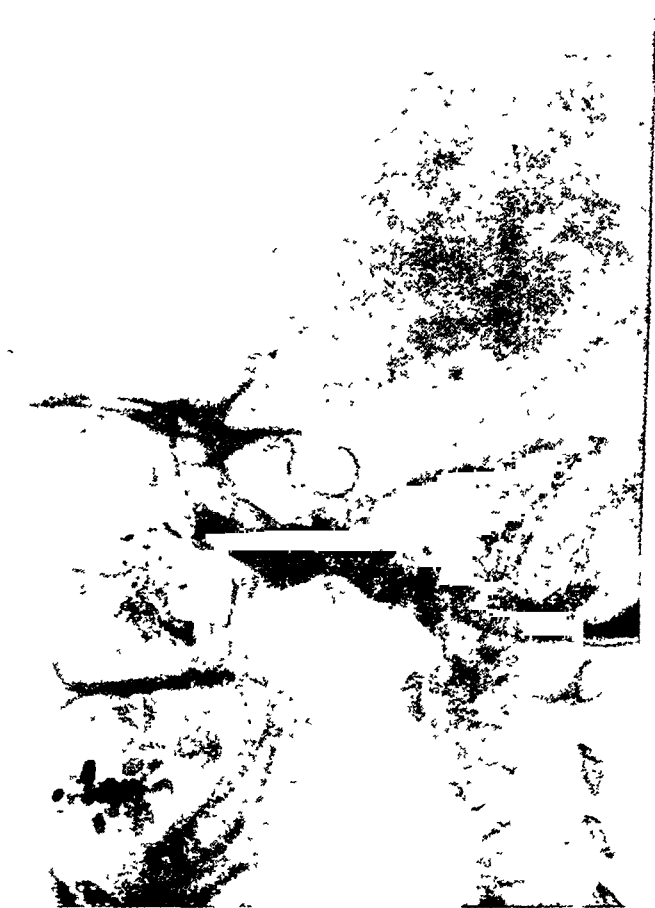
CASE I 24 hour film Fragmentation in the left antrum



CASE I. 76-hour film. Fragmentation persists in the left antrum but its position has changed.



CASE III 96 hour film Fragmentation of Radiopaque in the left antrum



CASE III. 96-hour film Fragmentation of Radiopaque in the left antrum



CASE IV 24 hour film shows rope like shadow of mucus mixed with lipiodol passing through middle meatus to naso pharynx

frontal, lateral or occipital, but chiefly on the left side, and are described as a dull ache.

In the displacement films on 7th May, 1943, the statim view shows a single pool of lipiodol elevated in her left antrum, and the right antrum is seen as a dense shadow which does not accept lipiodol. In the 96-hour films fragmentation of the radiopaque is visible in the left antrum though the pool has emptied.

It appears clear that the radiopaque has become intimately mixed with a plaque of mucus closely applied to an area of the sinus mucosa where the cilia are not functioning. At first it seemed unlikely that such an admixture could take place in view of the difficulty in producing such a mixture of mucus and lipiodol. But from the following case, where it is quite clear that such an admixture has taken place, we must infer that it does so.

In this case also from Rubery Mental Hospital, the lipiodol films are from a man aged 40 years. In the statim films there is a fair initial filling of the right antrum and right ethmoid, but there is very little filling in the left antrum, left ethmoid and both sphenoids. In the 24-hour film there is an unusual rope-like lipiodol shadow extending from the right middle meatus backwards and downwards towards the pharynx. This shadow is clearly due to radiopaque intimately mixed with mucus streaming out of the right antrum and swept posteriorly to the pharynx.

Fragmentation therefore appears to be an indication of ciliary stasis in the affected region of the accessory sinus involved.

DISCUSSION

The PRESIDENT suggested that the discussion might take the line, first, of all, as to whether the opening of an ostium could be achieved by simpler means, such as spraying. He was not putting forward any view on that subject, but was merely asking a question. Secondly, the merits of the conservative method had to be explored. In these cases of allergy he assumed that the determination of sensitivity to allergens had been estimated and any likelihood of the effectiveness of medical treatment had been considered. There was finally the question from the conservative method of trying to get some ephedrine into the sinus and the radical treatment of taking out the whole of the lining of the sphenoid instead of enlarging the ostium by a simple operation. The question of diagnosis came in, and Mr. Bedford Russell had expressed himself as glad that the supplementary paper by Mr. Stirk Adams should be included in the discussion. Therefore Mr. Stirk Adams's contribution was open to discussion at the same time.

H. G. DOWNER thanked Mr. Bedford Russell for his stimulating paper. He believed that this method of treating some regions of the nasal and paranasal sinuses was a valuable addition to therapeutic usages, and far more than a mere substitute for sprays. The object was to restore the damaged mucous membrane. So far as procedure was concerned, he had followed it first described down originally by Dr. Proetz. The symptoms of nasal obstruction, headache, coughing, and deafness were those which suggested that the method would be of value. The condition of the nasal mucosa and the appearance of the middle turbinates would confirm this. If the X-rays showed the same

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of a fluid level it was doubtful whether this could be met by replacement, and the treatment might cause a severe headache or aggravate one already present. The assessment of results was to some extent arbitrary, depending upon the observation of the patient or the parent. In his experience the most gratifying results were in children with a lengthy history of grave nasal obstruction, thick nasal discharge, and deafness. This observation was perhaps due to the rapid improvement in hearing which brought early recognition from the anxious parent. Recurrence was comparatively common, but experience showed that improvement would result.

To quote one case: he first saw a patient ten years ago—a boy who had every winter a series of acute febrile colds which would keep him in bed, sometimes for weeks, and prevent school attendance. During successive summers he carried out replacement treatment. X-rays showed thickened membrane lining of the antra. It appeared ridiculous to go on with the treatment. But since the age of 16 no further treatment had been necessary. The boy joined the army in 1940, and the speaker saw him six months previously, when he said that he could go through the winter, even living an outdoor life in this country, without fear of catching a severe cold.

The effect of the treatment on the tonsils was often satisfactory, but sometimes the treatment was not permanent until the tonsil was removed. It was useful to ascertain whether coryza or sore throat was the initial symptom. In the latter event replacement would be almost always of benefit. He showed statistics of the cases treated at the Worthing education clinic:

Total seen	..	..	..	..	..	..	..	131
Boys	..	..	..	..	..	..	..	59
Girls	..	..	..	..	..	..	..	72
Number of treatments	..	..	..	..	..	..	..	1,965
Symptoms relieved	..	..	..	..	..	..	..	93
Failure to report on follow-up	..	..	..	..	..	..	..	33
No improvement	..	..	..	..	..	..	..	9
Rank failure	..	..	..	..	..	..	..	2

The number failing to report was partly accounted for by the fact that many people had left the district.

The analysis of symptoms was as follows:

Cough, catarrh, and frequent colds, difficult to relieve	..	7
Aural discharge (relieved)	.. .. .	8
Tonsils: improvement	.. .. .	4
Tonsils removed before any improvement noticed	..	2

He would not claim that aural discharge would always clear up with displacement. It must be remembered that in these cases every other treatment had been tried before replacement was adopted. In two cases he had to remove the tonsils, and in four cases in which the children had been sent by the school medical officer for tonsil removal he decided not to carry it out, and did not do so.

T. B. JOBSON said that he had had one or two successes with this treatment but had always wondered exactly how it worked. He had felt that putting ephedrine into a sinus caused the mucosa to shrink up temporarily for three or

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four hours. He could never understand why ephedrine in a sinus could have these curative effects. It would be interesting to know the physiology of the treatment.

M L FORMBY said that Mr Bedford Russell had divided the cases into inflammatory and allergic and a combination of the two. How did he arrive at that classification, and was it a clinical or a pathological one?

J C HOGG said that he had the privilege of working with Mr Bedford Russell and saw many of his earlier cases. His own views on the subject were not quite crystallized. The more he had carried out the treatment the more confused he had become as to which were the most suitable cases for it. He had more negative views than positive ones. He thought that sometimes there was a very considerable risk in employing replacement treatment if the patient were caught in the wrong phase. Some patients were extremely sensitive to their own infection and sometimes organisms could be got into previously uninfected sinuses and there might be a considerable reaction. Such instances were not very common but they did occur, and they could be quite alarming when one came across them. Another difficulty was that sometimes the patient was in the early stages of coryza, in which case the displacement might cause much more extensive infection than the original coryza would have involved. That was a personal observation. He had tried it on himself in the early days when starting a cold and on two such occasions he had never had such a cold before or since! That was a word of warning.

R G MACBETH said that he agreed with Mr Hogg that it was extremely difficult to assess the value of this particular line of treatment. During the past six years he had used it on himself more than on anyone else, and had come to the conclusion that it was a bad thing to do in the acute phase of a nasal infection. He did not think the ephedrine helped in the slightest, normal saline was as good as anything else. He thought that such treatment was good for "tidying up" the end of a grumbling ethmoiditis in a nasal infection. On himself he had used, i.e. by displacement, a little weak penicillin left over from a series of mastoid cases and since he had done that he had found that he had not required this treatment any more.

Colonel NORTON CANFIELD, U.S.A.M.C., said that he does not use the method very often, but he did not mean by that that he held any view that it might not be a satisfactory thing to use. He had some staunch colleagues in his country who had used it extensively and were in favour of it, and he did not see the need of it. He had used lipiodol or an iodized oil of some kind, but in most cases in which he had done this it had been more confusing than helpful. There had been cases in which it had outlined a disease process especially tumours and there it was of value, but, generally speaking the passing of lipiodol into the sinuses by the displacement method for diagnosis had not been very helpful in his hands.

The PRESIDENT said that one method of application sometimes overlooked was in otology. If alcohol were injected into the meatus of a patient with a small perforation it might not get into the tympanic cavity.

BEDFORD RUSSELL in reply, speaking with regard to the President's last remark, said that he had tried this treatment with success in cases of perforation.

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in the ear-drum ; and he had also read recently in an American journal that it had been found useful in similar cases. It was well tolerated, and he had tried various solutions in the ear with advantage. One cogent question in treating sinus troubles was whether a diseased cell admitted the therapeutic fluid. It was the case here as in so many treatments, that the very cell which one wanted to get it into, might refuse to accept fluid. He thought that that happened very often to begin with : but supposing there were a troublesome antrum, and the surrounding ethmoids were all congested, it was an advantage to get the fluid into the surrounding cells and to get them a little more open, hoping that the antrum might follow suit ; so that although the first displacement might not succeed, a later one might do so.

With regard to skin tests for allergy, he had been disappointed in using them as a basis for treatment. The only information they afforded was that the *skin* was sensitive, *on that occasion*, to certain allergens. The spraying of allergens on to the nasal mucosa had been tried, but it was hard to get a dilution mild enough to avoid a severe response. He was wondering what particular medical treatment for allergy the President had in mind.

The PRESIDENT said that he had first in mind desensitization, on which opinions varied very much. Secondly, he referred to the use of calcium gluconate ; and also nitro-hydrochloric acid. Another measure was zinc ionization.

BEDFORD RUSSELL agreed that these measures were occasionally helpful. With regard to deafness, he mentioned his experience in the case of a medical colleague, aged 72, and in active practice, whose hearing improved slightly on politzerization. His hearing improved some 16 or 20 per cent. after displacement treatment. Dr. Jobson had asked how and why it did any good. The speaker thought that much of the effect was due to the fact that one was using a hypertonic solution. Mr. Macbeth had found that normal saline (he personally would have thought it better slightly hypertonic) served the purpose ; but he was of opinion that the addition of ephedrine helped.

Brigadier Formby had asked how he arrived at the classification into inflammatory and allergic ; that was merely a suggestion based on Dr. J. Freeman's thesis that allergy occurred in places in which the mucosa had previously been harmed. One pathological colleague used to put it that allergy was "half way to immunity". There was no particular scientific value in the diagram ; it was merely a graphic summing up of the probabilities. Mr. Hogg had said that he was confused by some of the responses and results ; so was the speaker, occasionally, and he had been engaged on this for over ten years. But he was sure that he was able to interpret, diagnose and treat the right patient more often ; and some day he would be able to crystallize the cases into types suitable and unsuitable. Mr. Macbeth's experience with colds in the acute stage was very different from his own, though occasionally inflammatory conditions did get stirred up by the treatment if the previous vaso-constriction were not thoroughly carried out. He had been trying to get penicillin ever since he had heard of it ; it seemed to be the ideal thing for displacement. Colonel Canfield said that he used lipiodol in diagnosis rarely, and found difficulty in interpretation ; the answer to the difficulty in diagnosis lay, probably, in the very fact that he had only used it rarely ; during the

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first two or three years of employing the method, one's diagnosis had been uncertain, but facility came with more frequent use

He appreciated Mr Stirk Adams's paper very much, having come to the same conclusions about the significance of fragmentation of the lipiodol shadow

The PRESIDENT, in closing the discussion, said that the Section was grateful to Mr Bedford Russell for bringing forward this paper and for helping to get some indications formulated as to the utility of the method

ABSTRACTS

EAR

Office Noises and their effect on Audiometry W D CURRIER (Boston) (*Arch of Otolaryng*, July, 1942, **XXXVIII**, 49)

There is much difference of opinion among otologists regarding the value of sound-proof rooms for hearing tests. The majority are content to use a room not specially sound proofed and in consequence the accuracy of the routine tests is more or less decreased, so that a comparison of records from various offices yield unreliable results

Using a sound (noise) level meter, the writer measured the extent of adventitious noise in a series of rooms employed for hearing tests. He found that the approximate noise level in the office of laryngologists was 35 decibels and in the rooms they employed for tests of hearing, about 24 decibels. Audiograms taken in these testing rooms were approximately 20 per cent less accurate than audiograms taken in a sound-proofed room. The audibility of high tones is little affected by extraneous noise. It is the low tones (below 2048 D V) that are chiefly impaired. The author concluded that a sound proofed room is essential for accurate audiometry. The paper is illustrated by 3 tables and 3 charts, and 27 references are given

DOUGLAS GUTHRIE

Acute and Chronic Mastoiditis. Clinical analysis of five hundred and twenty six consecutive operations C E TOWSON (Philadelphia) (*Archives of Otolaryngology*, July, 1943 **XXXVIII**, 32)

This paper gives statistical details of 526 consecutive operations on 466 patients in one hospital during a period of ten years. The operations for acute mastoiditis out-numbered the radical operations for chronic mastoiditis by about 2 to 1. The sex incidence was evenly divided and right and left ears were involved with equal frequency, while bilateral acute mastoiditis occurred in 18.8 per cent of the patients. The ages ranged from 6 weeks to 70 years, acute mastoiditis being most frequent between 4 and 12 years, and the chronic

type between 19 and 30 years. There were fewer operations since the introduction of sulphanilamide treatment but no special investigation of this fact was undertaken. Acute mastoiditis was more frequent during winter and spring months, the greatest number in March and April. The time relationship between the onset of otitis media and the operation for mastoiditis was carefully noted in a series of cases. The third week was found to be the optimum time for operation in acute cases, although many cases go on for much longer before operation, and afterwards make a steady recovery. The initial otitis may be so mild that it is overlooked; this accounts for the so-called primary mastoiditis (twelve cases in the present series).

Etiological factors were not easy to trace, but head colds, measles, and scarlet fever predominated. The writer does not mention the frequency of nasal sinus infection in mastoiditis but quotes other authors who have noted that the association is very common.

Regarding bacteriology, about twenty-two different organisms were isolated, by far the most frequent being streptococcus hemolyticus.

Early myringotomy is strongly advised in acute otitis media. Most patients with acute mastoiditis had a leucocyte count of 12,000 to 18,000. X-ray examination was a valuable and accurate aid to diagnosis in most of the cases. In 19 per cent. of the cases of acute mastoiditis and 20 per cent. of the cases of chronic mastoiditis there were intracranial complications. Perisinus abscess was the commonest of the complications—34 in acute cases, 13 in chronic cases. Cerebral abscess was present in 7 cases, cerebellar abscess in 4 cases. About one-half of the cases of chronic mastoiditis showed cholesteatoma; other writers have found it to be even more frequent.

The mortality rate in the series was 5.8 per cent.; 6.6 per cent. in acute and 4.5 per cent. in chronic cases. The most usual cause of death was meningitis. The great majority of patients recovered, with dry ears—98 per cent. of acute cases and 90 per cent. after radical operations. Sixty-three per cent. of the radical mastoidectomies heard as well or better after the operation, the extent of deafness depending upon the duration of the disease before operation. The statistics showing all the data are given in the 27 tables which illustrate this instructive paper.

DOUGLAS GUTHRIE.

Labyrinthitis secondary to Tympanic Infection. PHILIP MYSEL. (*Annals of Otol.* (St. Louis), 1942, li, 761.)

It is the opinion of the author that in such cases there should be no surgery during the acute stages of labyrinthine inflammation. If, however, there are signs of threatening meningitis, he recommends that labyrinthectomy be performed. A radical mastoid is not sufficient, but merely exacerbates the condition. To wait for signs of established meningitis, before the advent of chemotherapy, spelt certain death, and even now the prognosis is much better and the likelihood of cerebellar abscess much less, if operation is performed in the stage of meningeal irritation.

Operations should not be undertaken in the presence of localized labyrinthitis, or they may cause a spread of the infection to the intracranial areas. If such a labyrinthitis subsides without any intracranial complication, several

Larynx

weeks should be allowed to pass before the radical mastoid operation is performed, and that should be carried out with the electric burr, rather than with gouge and hammer, as this is less likely to cause trauma and precipitate a meningitis

Mortality for the period 1923-1933 for labyrinthitis with meningeal complication was 72 per cent, during the period 1934-1942 it has fallen to 33 per cent. This is due to

- 1 Early diagnosis
- 2 Conservative treatment in the absence of intracranial symptoms, and
- 3 The local application of sulphanilamide powder and the oral administration of sulphadiazine

F C ORMEROD

LARYNX

Congenital Cyst of the Larynx (Lancet, cccxlv, 508)

Dr Jane Davidson reports this case in a child which developed signs of laryngeal atresia twelve hours after birth, and died forty-five days later. It is suggested that the cyst arose by atresia of the laryngeal ventricle—a rare condition. Diagnosis can be made by laryngoscopy or by palpation. Treatment is by resection or simple puncture of the cyst after preliminary tracheotomy.

MACLEOD YEARSLEY

Neurofibroma of the Larynx EMILY L VAN IJON and SYDNEY DIAMOND
(Anal. Otol (St Louis) 1942 11, 122)

Neurofibroma of the larynx is so rare that only one case was seen in the Mayo Clinic in thirty years. Five others have been reported by Jackson Colledge Vail, Tucker and Holmgren and Bergstrand. The present authors describe a case at the Temple University Hospital, Philadelphia.

Of these seven cases all but one were in females and the age varied from 17 to 50 years of age. In Colledge's case alone was there generalized neurofibromatosis. The increase in size of these tumours appeared to be very slow and in three cases there was dyspnoea. In one case there was dysphagia. The new case now recorded occurred in a girl of 17 who gave a history of one year's hoarseness. Attempts to obtain portions for histological examination were unsuccessful, and after watching steady growth of the tumour it was excised by means of laryngofissure. The mucous membrane was incised and dissected off the tumour which was found to be encapsulated and was removed with great care and recovery was uneventful though the voice has remained husky. The tumour was a neurofibroma.

In the seven cases the tumour was removed twice by suspension laryngoscopy, four times by laryngofissure and in one it was left *in situ*. In each case in which it was removed the dissection of the tumour was very easy and Ewing states that the ready enucleability of this tumour is characteristic. In none of these cases has recurrence been noted.

F C ORMEROD

Abstracts

ŒSOPHAGUS

Treatment of Impermeable Stricture of the Œsophagus by External Manipulation.

FLETCHER D. WOODWARD. (*Annals Otol.* (St. Louis), 1942, li, 94.)

The author describes three cases of impermeable stricture of the œsophagus—two due to drinking lye and one due to marked spasm of the cricopharyngeus muscle.

The first lye case was a boy of 12 who had an impermeable stricture in the upper third of the œsophagus. A gastrostomy was performed and after further attempts had failed, the upper part of the œsophagus was exposed and isolated in the neck. Attempts to penetrate the stricture from above failed, but a bougie passed *viâ* the gastrostomy, and manipulated by the surgeon's right hand, and guided up the cervical œsophagus by his left hand was successfully led through the stricture, after which full dilatation was possible.

The second case was that of a woman of 73 with an unyielding spasm of the upper sphincter: it was treated by cervical exposure of the œsophagus, and by manual manipulation of bougies the œsophagus was found and dilated with complete success.

The third case was a woman of 27 who had swallowed large quantities of lye and had one stricture in the upper and another in the lower third. All attempts to permeate these strictures by the usual methods had failed and so a high abdominal incision was made and a bougie passed *viâ* the stomach and manipulated through the lower stricture. Later a cervical incision was made and the gullet exposed, but no permeation could be achieved from above. The lower stricture had by this time stenosed again and it was not possible to pass a bougie upwards to the cervical stricture though the surgeon considers that if that could have been done, the upper stricture could have been dilated. He proposes to make another attempt on this case and thinks that this method of external exposure and manipulation will result in many otherwise impermeable strictures being dilated.

F. C. ORMEROD.

MISCELLANEOUS

Patulin—The Common Cold. Harold Radstock (*Lancet*, 1943, ii, 627) in collaboration with Surgeon Commander W. A. Hopkins, R.N., and Major Greenwood, in an exhaustive and important article remark that the etiology of the common cold is not yet fully understood, and with the etiology and pathology of this common trouble in its present unsatisfactory position it is difficult to decide as to the merits of a new curative agent because the duration and severity of colds vary greatly with the individual and because a cold is a self-limited disease. The writer claims encouraging results for *Patulin*, which has been given an extensive trial in the Royal Navy. In his summary, the author states that *Patulin* is about equally bacteriostatic to both gram-positive and gram-negative organisms; it is much less active than penicillin against gram-positive organisms but much more so against gram-negative ones. During the first four months of this year *Patulin* was tried in common colds, either by nasal spray or snuffed up from the hand. The results were encouraging, 57 per cent. of the cases recovering completely within 48 hours as compared with 9.4 per cent. of the controls. No ill effects were observed. *Patulin* is a derivative of *Penicillium patulum*.

MACLEOD YEARSLEY.

The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

September 1943

THE INVESTIGATION OF MÉNIÈRE'S DISEASE*

By C S HALLPIKE (London)

From the Research Unit National Hospital Queen Square London

In a certain proportion of patients in whom vertigo occurs in association with deafness, the signs and symptoms are readily recognizable as being due to inflammatory or neoplastic processes involving the labyrinth, the VIIIth nerve or its connections within the brain-stem

When these have been excluded there still remains a considerable group long recognized, at any rate in this country, as a well-defined clinical entity and variously referred to as Menière's syndrome, Menière's disease, aural vertigo, etc. In these, the vertigo is characteristically paroxysmal, is often associated with nausea, vomiting, deafness and tinnitus, and occurs in the absence of any other neurological abnormalities

The histological changes in the labyrinth in two cases clinically characteristic of this group were described in 1938 (Hallpike and Cairns). Similar findings were revealed in a third case (Hallpike and Wright, 1939). Since then changes almost identical in character have been described in the affected temporal bones of all of five subjects examined in Witmaack's laboratory by Rollin (1940).

Although certain differences of opinion are likely to continue as to the precise mechanism which underlies the essential feature common to these findings, namely the endolymphatic distension, and relates it to the clinical manifestations, it seems justifiable to regard this work as establishing the morphological basis of this disorder.

The clarification of existing views effected thereby takes two forms. In the first place, it has been shown that gross organic changes occur within the labyrinth and not in the VIIIth nerve, and that in type they

* Paper read to the Section of Otology, Royal Society of Medicine, May 7th 1943

conform with startling exactness to the state of endolymphatic hypertension, which had been postulated by Jenkins, Portmann and others.

In the second place, the remarkable uniformity in all of the cases examined of histological changes so peculiar in character suggests that they are due to a specific disease process of the labyrinth, and in this way contradicts a not uncommon but quite opposite view that the disorder could be regarded as a symptom-complex due to a wide variety of pathogenic agents acting within the labyrinth upon the sensory elements, their vascular supply or the labyrinth fluids.

The present paper deals with certain results of investigations of the clinical features of this disorder which have been in progress at the National Hospital for the last two years.

For the greater part the clinical material has been provided from the Out-Patients' Department. All the patients suffered from paroxysmal attacks of vertigo, usually associated with deafness and tinnitus. No other neurological abnormalities were present. A blood Wassermann test was carried out in the majority and was negative in all.

The Technique, Results and Significance of the Caloric Tests

The tests in question are the caloric tests of Bárány modified in the light of experience and of certain theoretical considerations. The tests are carried out with the patient lying comfortably on a couch, with the head raised 30° from the horizontal. Four tests are carried out, two on each ear, with water at 30° and 44° C. Each ear is irrigated for 40 seconds at a constant and fairly free rate of flow. Throughout the tests, the eyes are fixed in the straight ahead position upon a convenient spot on the ceiling. The resultant nystagmus is therefore of the second degree variety and is observed with good illumination from a head mirror at a distance of about 12 in. The measure of the response is taken as the time in seconds between the application of the stimulus and the end of the response. This is conveniently, though inaccurately, described as the response duration. Actually it represents a lumping together of latent period and response duration. For our own purposes, we have not found it an advantage to take special account of the latent period.*

The results are expressed in the form which is shown in Fig. 1. Each continuous line represents a three-minute period, subdivided into intervals of minutes, 20 seconds and 10 seconds. The reactions of the left and right ears are denoted by L. and R., while the stimulus time extends in all over the first 40 seconds. The interrupted lines denote the response durations. For further reference the responses are numbered 1-4 from above downwards. In responses 1 and 4 the direction of the nystagmus is of course to the right. In responses 2 and 3 the nystagmus is to the left.

* For further particulars of the rationale and technique of the caloric tests as modified, reference should be made to *Brain*, 1942, lxx, 115.

The Investigation of Ménière's Disease

The response pattern shown represents the average normal, with the two cold reactions close together at about two minutes and the two hot reactions also close together and of rather shorter duration. In agreement with all observations since Bárány, we have found that these reactions vary widely in normal individuals. Nevertheless, this variation is

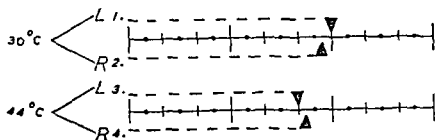


FIG. 1.

Normal.

(Reproduced by permission of the Editor of *Brain*)

chiefly in respect of their general magnitude. The pattern of the responses which determines their diagnostic worth varies much less.

Principles underlying tests.—Emphasis is laid upon three points which underlie the rationale of these tests.

(a) *Temperature of the stimuli.*—The organ which is chiefly, and it may be solely, involved is the external canal. For reasons which will be apparent, it is desired that the deflecting powers of the stimuli upon the cupula should be equal and opposite. The temperatures used are therefore 30° and 44° C., 7° below and above body temperature.

(b) *Intensity of the stimuli.*—It is desired that the test should be as sensitive as possible, that is to say, that it should be capable of revealing the smallest significant changes in sensitivity of the cupular end-organs.

Fig. 2 shows the typically sigmoid form of the stimulus intensity-response curve of a number of receptors stimulated together. From this it is clear that for maximum sensitivity the stimuli should be of

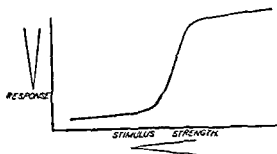


FIG. 2.

moderate intensity, i.e. that they should fall upon the rising portion of the curve. In the case of the caloric reactions, this condition is fulfilled in the majority of individuals by free irrigation for 40 seconds at 30° and 44° C.

C. S. Hallpike

(c) *The necessity for using both cold and hot stimulation.*—This is required for the demonstration of the phenomenon originally described as nystagmusbereitschaft and to which we have given the name of directional preponderance (FitzGerald and Hallpike, 1942). To explain this, it will be necessary to answer three questions: (1) What is directional preponderance? (2) How do the caloric tests reveal it? (3) What is its practical significance when revealed?

(1) Directional preponderance: The phenomenon of directional preponderance of induced vestibular nystagmus was first recognized and described in 1923 by Dusser de Barenne and de Kleyn from the results of certain animal experiments. Working with rabbits, they found that removal of one cerebral hemisphere led to a facilitation of the nystagmic response to any form of vestibular stimulation which produced nystagmus in a particular direction, i.e. with its quick component towards the ablated hemisphere.

Thus, with removal of the right hemisphere, there was an enhancement in the responses of the right ear to hot stimulation and of the left to cold. Similarly, with rotation, there was an enhancement of the response consisting of nystagmus to the right to a cessation of rotation to the left.

An application of these results to the human subject was described by FitzGerald and Hallpike in 1942 who found that directional preponderance did occur in association with some cerebral lesions, but that its occurrence and direction were dependent upon the involvement of one or other of the temporal lobes.

(2) Alterations of caloric responses due to directional preponderance: In Fig. 3 at A the normal pattern of the caloric responses is shown again for reference. B shows directional preponderance to the right resulting from a lesion of the right temporal lobe, i.e. facilitation of the left cold and the right hot responses, both of which consist of nystagmus to the right. With a lesion of the left temporal lobe, there occurs directional preponderance to the left (C), i.e. facilitation of the right cold and the left hot responses, both of which consist of nystagmus to the left.

It is of particular importance to note that of these four reactions, which go to make up the pattern of a directional preponderance, each ear contributes a particular disturbance of its own two reactions. Thus, in the case of directional preponderance to the right, the normal relationship of the cold to the hot reactions of the left ear is altered in favour of the cold, and of the right ear in favour of the hot. It follows that when two of these reactions are eliminated from the pattern, as for example, when one labyrinth is defunct, the presence of a directional preponderance can still be correctly deduced from a characteristic alteration in the responses of the opposite ear. This situation is of importance inasmuch as directional preponderance may arise, as will be seen, as a result of unilateral labyrinth destruction.

The Investigation of Ménière's Disease

The occurrence of directional preponderance in Ménière's disease was first recognized by Vogel of von Eicken's clinic, who in 1929 gave a very clear account of its occurrence in a number of characteristic cases. Vogel was aware of the work of Dusser de Barenne and de Kleyn upon the effect of cerebral lesions in producing directional preponderance and was led thereby to suggest that his own findings argued in favour of the theory that the lesion in Ménière's disease was situated in the central nervous system, and not in the labyrinth.

(3) The mechanism and significance of directional preponderance due to labyrinthine lesions: In this, our own views have been advanced

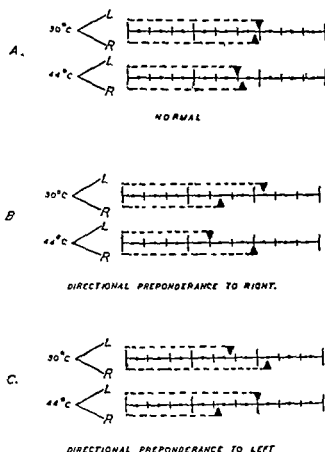


FIG 3

by certain observations upon the effects of unilateral labyrinthectomy carried out for intractable Ménière's disease upon the caloric responses of the opposite ear. Present knowledge of the effects of unilateral labyrinth destruction in the human and of their physiological basis is founded upon the work of Bárány. In the great majority of his patients, the destruction was due to suppuration. Following the abatement of spontaneous nystagmus to the opposite side, which is characteristic of the period immediately after the destruction, Bárány found that his patients showed a constant deviation from the normal response to rotation in that there occurred a marked preponderance in the nystagmic response to a cessation of rotation to the side of the affected ear. His findings

are illustrated in Fig. 4, which shows the head with the two horizontal canals from above. The left labyrinth has been destroyed. Rotation now affects the right labyrinth alone. Comparing post-rotational nystagmus to the left and right, Bárány found that much the bigger response, consisting of nystagmus to the right, occurred on stopping a steady rotation to the left.

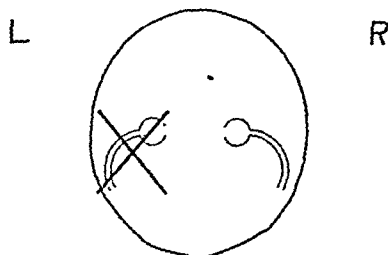


FIG. 4.

Directional preponderance of rotational nystagmus after destruction of left labyrinth. Nystagmus is greater on stopping a steady rotation to the left.

rotation to the left; the ratio of this response to its opposite being characteristically 2:1. According to Ewald's law, the external canal reacts chiefly to ampullo-petal flow of endolymph, and if this law be accepted as valid for the human subject, then according to Fig. 4 the right canal, which remains to respond alone, should correspondingly give a bigger response to ampullo-petal flow. Such a flow does result from a cessation of rotation to the left and results in nystagmus to the right. This was exactly what Bárány found and since it was exactly in accordance with Ewald's law, he accordingly regarded this law as confirmed and illustrated by his findings. He also noted that this preponderance in the effect of a rotational stimulation causing an ampullo-petal flow of endolymph became gradually lessened in the course of time. This effect, sometimes known as Ruttin's reaction, he attributed to processes of central compensation.

Although Bárány is best known for his work in connection with the caloric tests, he never established these upon a quantitative basis. On the other hand, he developed very fully the quantitative possibilities of the rotational tests.

Our own approach to the clinical problem of unilateral labyrinth destruction differs from Bárány's in a number of important respects. In the first place, we have made use of the caloric tests both hot and cold, applied in a quantitative manner. In the second place, the labyrinth destruction in our patients was carried out as a surgical procedure as a part of their treatment for Ménière's disease. It was therefore possible for us to examine the caloric responses, in particular of the healthy ear, before as well as after labyrinth destruction.

The Investigation of Ménière's Disease

Owing very largely to these differences in the manner of our approach, we have been led to conclusions which differ radically from those of Bárány and for reasons which are contained in Fig. 5. This shows the caloric reactions before and after labyrinthectomy of a man who had an eighteen months' history of vertigo and vomiting with increasing deafness of the right ear. Apart from a slight diminution in the responses of the right ear, the caloric responses were normal. The first important feature about this diagram is the greater magnitude of the cold responses. The cold and hot temperatures are selected as being equidistant from

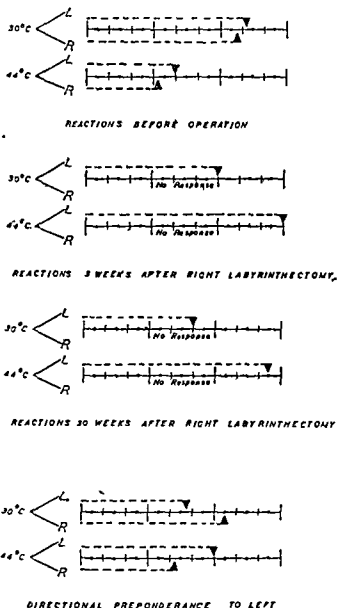


FIG 5

body temperature and are therefore calculated to produce equal and opposite effects upon the canal cupula. Now according to Ewald's law, the hot stimulus which causes an ampullo-petal flow of endolymph should give much the bigger response. In fact, however, the cold is the more effective stimulus and our findings over some hundreds of tests

show that the cold responses are the greater in the majority of cases. In some, the responses are equal, while in a few the hot responses slightly exceed the cold. The first conclusion, therefore, to be drawn from this diagram is that Ewald's law does not apply to the external canal of the intact human subject. Instead, the canal may be said to exhibit bi-directional sensitivity to endolymph movement.*

The second matter to be considered is the behaviour of the reactions of the sound ear, reactions 1 and 3. Before the destruction of the right labyrinth, these two reactions exhibit a relationship which is described as normal, with the cold responses exceeding the hot. Three weeks after the operation, however, this relationship is strikingly altered, and the hot response, consisting of nystagmus to the left, is now much larger. Comparison of this with the full pattern of a directional preponderance to the left, shows that while two of the elements have been eliminated by the destruction of the right labyrinth, nevertheless the remaining two reactions of the left ear show the identical disturbance in their relationship which is found here to be characteristic of directional preponderance to the left. In other words, directional preponderance to the left has here been brought about by destruction of the right labyrinth.

If such a patient is examined in a Bárány chair, it will be found, as Bárány found, that there is a marked preponderance of the nystagmic response to the left which occurs on stopping a rotation to the right. If further, the hot and cold responses of the left labyrinth continue to be investigated over a period of months, then it will be found, as in this patient, that the preponderance of the hot response gradually disappears. Again a result which is familiar in the form of the so-called Ruttin reaction. Whereas, however, Bárány regarded such a preponderance of the nystagmic response towards the sound ear following destruction of one labyrinth as merely exemplifying and confirming Ewald's law, in other words, that in these circumstances the remaining external canal and its associated central connections are left alone by a process of simple subtraction to respond in their normal manner, it is clear from these diagrams that the normal responses of the left canal, shown in reactions 1 and 3, themselves contradict Ewald's law and that the directional preponderance which they exhibit after the destruction of the right labyrinth is a pathological state resulting from that operation. Since throughout the left canal itself has remained intact, it follows that these changes in its responses are of central origin. In this way, therefore, it becomes possible to say that *directional preponderance in these circumstances is a pathological change in the central responses of the external*

* The usual preponderance of the cold response is in part due to the greater fall in the temperature of the hot water in course of its passage to the ear. This renders it physiologically less effective as a caloric stimulus than the cold water.

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canal due to destruction of the opposite labyrinth, whether by suppuration or surgical exenteration

The establishment of this point is important for two reasons. In the first place, it gives promise that further analysis of the known effects of unilateral labyrinth destruction will lead to an explanation of the underlying mechanism of directional preponderance. In the second place, it makes it possible to regard without surprise, and indeed to anticipate, the occurrence of directional preponderance in the natural course of any disease of the labyrinth involving a loss of its function, in particular, Meniere's disease.

Dealing first with the physiological basis of the well known effects of unilateral destruction of the mammalian labyrinth, both in man and animals the immediate effects are severe and dramatic. As Magnus showed, these effects are essentially the same whether the labyrinth function is destroyed by surgical exenteration or by cocainization, and we must therefore agree with him in concluding that they are of paralytic origin. Our present needs will be served by confining ourselves to the consideration of one alone of these effects, namely, spontaneous nystagmus to the opposite side. In man this usually persists for about a week and is immediately followed, as described, and as we have now observed in all of more than a dozen cases, by a directional preponderance of caloric or rotational nystagmus in the same direction. The correspondence in direction and the unbroken transition between the original spontaneous nystagmus and the directional preponderance which succeeds it, make it extremely probable that the latter is a residuum of the former and that both should, therefore, be explicable upon the same basis.

The physiological basis of spontaneous nystagmus following unilateral labyrinth destruction—Fig. 6 shows in diagram form certain principles governing the vestibular control of human eye movements in the horizontal plane, which it is reasonable to accept as established. For the purpose of simplicity, the two eyes are replaced by one which is moved by two sets of muscles, its left and right turners each activated by its particular set of motor cells, labelled as motor cell groups.

Nystagmus is a compound ocular movement of which the slow deviation is the primary element and is usually initiated from the periphery. The quick component follows the slow and is initiated by it through a reflex mechanism subserved by certain subsidiary cell groups which according to Lorente de Nó are located within the substantia reticularis. For the present purpose, the slow deviation is the primary element and it is the slow deviation which has been made the basis of the diagram (Fig. 6). The impulses which reach the motor cell groups from the labyrinths are of two kinds. There are firstly the tonic impulses, represented by continuous lines. The bulk of the evidence at present

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It has been of the greatest interest to compare these results with results described by de Kleyn and Versteegh in an important paper to which our attention has recently been directed, published in 1933. Their results are also shown in Table II. They agree with Vogel in finding

TABLE I
HALLPIKE AND CAWTHORNE—100 CASES

	Normal	Directional preponderance	Canal paresis	Directional preponderance canal with paresis
	%	%	%	%
First 50 cases	6	20	58	16
Second 50 cases	18	22	40	20
Total 100 cases	12	21	49	18

TABLE II
DE KLEYN AND VERSTEEGH—100 CASES

Normal	Nystagmus- bereitschaft	Unequal sensitivity of the two labyrinths
%	%	%
16	11	73

directional preponderance, but in addition they find many cases in which the caloric tests gave results corresponding to our own group of canal hypofunction. The technique of stimulation which they used was Kobrak's, using both cold and hot water and, if account be taken of the difference in the two methods of testing, the two sets of results show a fair measure of agreement.

De Kleyn and Versteegh do not attempt to explain the mechanism of these abnormalities and indeed express their acceptance of the vascular spasm theory as the pathological basis of the disorder. This consideration is, however, of less concern than the fact that these particular abnormalities in the caloric reactions do occur, and in this respect, our own agreement with the earlier findings of de Kleyn and Versteegh, arrived at quite independently, is worthy of considerable emphasis.

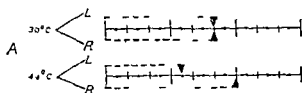
In addition to these two types of change, certain others have been encountered. These occur quite frequently and their nature and significance were for some time obscure. One such change is shown in Fig. 7. While the two cold responses are approximately equal, there is a gross inequality in the hot responses. A change of this kind, when it occurs, is usually associated with deafness in the left ear and is therefore likely to be due to disease of the left labyrinth. This being so, it has seemed reasonable to suggest that it might be due to lesions of the left canal and utricle occurring in combination.

How these lesions may combine to produce the result is shown in Fig. 7. B is the pattern of a left canal lesion; C the pattern of a left utricular lesion with directional preponderance to the right. B is

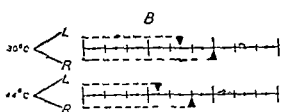
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combined with C by shortening reactions 1 and 3 in C The result reproduces the original pattern A

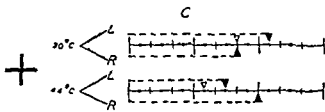
Combined lesions of left external canal and left utricle



||



Lesion of left external canal

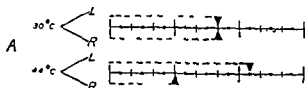


Directional preponderance to right
Lesion of left utricle

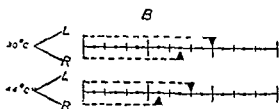
FIG 7

Another variety of irregularity, produced probably in a similar way, is met with nearly always in association with a deafness of the right ear. Its pattern is shown in Fig 8. The two cold reactions are again close together, while once more the hot reactions diverge widely. In this case, however, the direction of the divergence is opposed to that seen in Fig 7A,

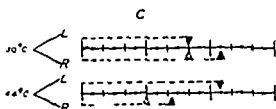
Combined lesions of right external canal and right utricle



||



Lesion of right external canal



Directional preponderance to left
Lesion of right utricle

FIG 8

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in which the right exceeded the left. Here the left exceeds the right. B is the pattern of a right canal lesion and C is the pattern of a right utricular lesion with directional preponderance to the left. B is combined with C by shortening reactions 2 and 4 in C. The result reproduces the original pattern A.

Referring again to the table, we see that of 100 cases, reactions of this kind were encountered in 18.

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THE TREATMENT OF MÉNIÈRE'S DISEASE*

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ALTHOUGH Ménière's disease does not cause any obvious pathological changes in the body apart from the labyrinth it can, by the very violence of its symptoms, reduce the sufferer to a state of chronic invalidism. Thus it requires a person of robust temperament to bear with equanimity the disturbance both mental and physical that forms part of the recurrent attacks. Those who are unable to stand up to the ordeal will exhibit symptoms of nervous strain in varying degree. Such patients do not always respond easily to treatment because even if they are relieved of their severe attacks they may find difficulty in regaining self-confidence. They require constant encouragement and careful rehabilitation, particularly if they have been submitted to operation. Another factor to be considered, especially when any particular form of treatment is being assessed, is the natural tendency of the disease towards spontaneous remission, and it is important to guard against attributing such a remission to a successful response to treatment.

Before describing in detail two forms of treatment that have been found helpful a short review will be given of some of the more generally accepted measures for the alleviation and treatment of Ménière's disease.

Sedatives have long been in use and of these phenobarbital has established itself as the most popular, and rightly so, for regular doses of this drug seem to discourage the spread of the disturbance caused by an attack to other parts of the central nervous system.

That overloading of the affected labyrinth with fluid played a part in causing the symptoms may have been suspected by Politzer (1893) when he advocated pilocarpine. This theme was elaborated by Dederding (1929) who postulated a general condition of fluid retention due to abnormal water metabolism for which she advised diuretics and a reduced fluid intake. Furstenberg, Lashmet and Lathrop (1934) carried this a step further and described a régime that favoured excretion of the fluid-binding sodium. These measures have been employed often with good results in cases where the strict dietetic régime is and can be faithfully followed.

Recently Shelden and Horton (1940) have reported on the value of histamine in a certain proportion of cases and this has been confirmed by others, although no one is quite clear why this should be. In the small number of cases in which we have used histamine about one-third have been helped.

* Paper read to the Section of Otology, Royal Society of Medicine, May 7th, 1943

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It has been suggested by Atkinson (1942) that a favourable response to histamine treatment can be expected in allergic cases that give a positive skin reaction to histamine, but it is not certain how much reliance can be placed on such a skin test.

Nicotinic acid has been advocated by Atkinson (1942) for its vasodilatation effect. We have no experience of this form of treatment.

Inflation of the Eustachian tube has been practised extensively although opinion differs as to the number of cases of Ménière's disease that are associated with Eustachian insufficiency. We very rarely see it, and we do not think that the false negative Rinne that is so often noted in unilateral perception deafness in any way indicates a lesion in the conducting part of the auditory mechanism.

Wright (1938a) has found that relief from attacks can be expected when a focus of sepsis is found and eradicated. We have examined all our cases for evidence of oronasal sepsis and have taken suitable steps to remove any that has been found, with improvement in some cases. The proportion of such cases has, however, been small and it would seem doubtful whether infection in the nose or throat plays a very important part in the causation of the disease.

Of the operative measures employed the most rational would seem to be drainage of the saccus endolymphaticus as advocated by Portmann (1927). Woodman and Adams (1939) have also described several cases in which this has been done. We have attempted this operation in two cases. In one, the saccus was opened, but the other presented difficulties that made it impossible to be sure that the saccus had been opened. In the first there was a gradual loss of activity, leading slowly to complete extinction of function. In the second there was but little post-operative disturbance and no loss of function. Drainage of the perilymph space was advocated by Hautant and others and Mollison (1935) and Mill (1936) have each reported series of cases in which alcohol was injected into the labyrinth after opening the perilymph space of the external semicircular canal, thereby destroying all function. After the initial post-operative disturbance was overcome this procedure resulted in the abolition of paroxysmal attacks. The cases that we have treated in this manner have resulted in complete absence of response to both cochlear and vestibular stimulation.

Section of all or part of the VIIIth nerve has long been in favour, especially in America where Dandy (1928), and in France where Aubry and Ombredanne (1937), have reported large series of cases. In this country Cairns and Brain (1933) have also reported good results. Recently all these workers have contented themselves with section of the vestibular division of the VIIIth nerve only, leaving the cochlear division intact, so that what remains of the hearing will not be disturbed. In this connection it may be mentioned that the disease may cause such distortion

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of hearing on the affected side that any but the softest of sounds are distressing, and several of our patients have volunteered the information that the loss of distorted hearing on the diseased side has enabled them to listen to loud sounds such as the wireless and children's voices without discomfort

Wright (1938b) injects alcohol into the perilymph space through the tympanic membrane and stapes footplate. This gives the same results as the other forms of alcohol injection and it has the great merit of being surgically simple

There are two variations of the forms of treatment mentioned that we have found helpful. We have been using a combination of hyoscine gr $\frac{1}{100}$, hyoscyamine gr $\frac{1}{100}$ that is the basis of a well-known and I am told effective sea-sick remedy known under the proprietary name of "Vasano". One to three of these tablets a day is often sufficient to keep the attacks at bay, but excessive dryness of the throat or transitory blurring of vision may call for a smaller dosage or changing over to a mixture of luminal gr $\frac{1}{2}$ and pilocarpine gr $\frac{1}{10}$ to be taken two or three times daily

If this or a combination of the other conservative measures already mentioned does not keep the symptoms in check, then the possibility of destruction of function is considered. We do not favour the operation that is to be described unless the disease cannot be checked by conservative treatment and unless there is a considerable loss of hearing on one side and good hearing on the other. Of the cases under review 20 per cent have been submitted to operation and as a number of other cases have been seen during this period that have not been included it is probable that less than 15 per cent of all cases seen have been operated on.

We have found that in order to abolish function in the labyrinth all that is necessary is to open the endolymphatic space. We have found that the injection of alcohol is not essential as the same results can be produced by merely opening the membranous labyrinth. In order to ensure that the endolymphatic space is properly opened we now remove a portion of the membranous labyrinth from the external canal, this part of the labyrinth being chosen as being the most accessible.

In order to do this it is necessary to work in a magnified field and for this we have since 1938 been using a Leitz binocular dissecting microscope giving 10 diameters of magnification. We have tried with 5 and with 20 diameters, but have found that the 10 diameter magnification is the most convenient. This particular dissecting microscope has the great advantage of having a working distance of 22 cm. between the microscope and the object, thus enabling the operation to be carried out without transgressing the aseptic ritual. Such an instrument has been in use for many years in animal otological surgery. Holmgren (1923) was the first to use a binocular dissecting microscope for operations on the

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labyrinth. Tullio of Parma (1938) described its use in mastoid surgery, and more recently Shambaugh (1942) in America has used it in the surgical treatment of otosclerosis. We have found the microscope to be of very great help in many operations on the temporal bone, particularly in those on the facial nerve (Cawthorne, 1941) and the internal ear.

The approach to the labyrinth is *viâ* the mastoid, sufficient bone being removed to ensure a good view of the external semicircular canal. This calls for enlargement of the aditus and removal of the incus. Care is taken not to encroach upon the osseous meatal wall for fear of opening into the external meatus, because it is felt that such an incident may prejudice healing by first intention. In the case of a cellular mastoid no attempt is made to open up all the cells or indeed any more than are necessary to obtain a proper exposure of the canal. For this part of the operation it is neither necessary nor is it particularly convenient to use the microscope. When the canal has been adequately exposed, especially in the antero-inferior aspect of its convexity, the bone in this region is carefully and slowly removed with a dental burr under the microscope. We have found that a diamond dust burr is easier to work with than the ordinary steel burr because if does not get clogged with bone dust, it remains sharp indefinitely, it has a very gentle bite and it is less inclined to slip or run. We use a portable dental machine working at 3,000 revolutions per minute. Working the drill along the convexity of the external canal in its lower half, backwards and forwards through an excursion of about 5 mm. a trough is gradually excavated. As the lumen of the canal is approached it will be possible to see a dark tache in the trough which marks the line of the lumen. This is followed forwards and backwards so that from 5 to 10 mm. of lumen will be exposed. As soon as the lumen is opened perilymph seeps through and converts the dry bone dust into a soggy mass like wet sugar. The remainder of the exposure is then carried out with sharp dental instruments, and when the debris has been cleared away the transparent membranous canal will be seen in the upper part of the lumen like a fine glass tube. This is seized with fine forceps and removed, a procedure that sometimes is tedious, as the membranous tube may be elusive. Once this has been removed the operation is ended and the mastoid wound stitched up without drainage. So far 52 cases have been operated on, of which 20 occur within the present series of 100 cases under review. All have healed by first intention and there have been no complications. The immediate post-operative effect has been the same as in other forms of labyrinth destruction and the degree of post-operative disturbance has been largely governed by the amount of function that was present in the affected labyrinth before operation. Where there has been but little function beforehand, and I refer of course to the vestibular part, there is

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likely to be but little disturbance afterwards, and conversely where the response to the caloric test has been active, the post operative disturbance will be much more marked. In this connection it may be mentioned that marked pre operative impairment of function is the probable explanation of the observations of Dandy (1928) and Symonds (1933) that section of the VIIIth nerve causes but little disturbance, we cannot think of any grounds for believing that section of the nerve will cause less disturbance than destruction of the end organ. It is not necessary to describe in detail the nature of the post operative disturbance, the typical picture of acute vestibular failure with the patient lying usually on his sound side, his head almost pushed into the pillow for support against the vertigo, a vomit bowl at hand and the eyes closed. He dislikes any movement and if he opens his eyes he will be found to have an obvious nystagmus, even when looking in the direction of the slow component. In fact it is not easy to get him to look in any other direction. This will be the picture if there was a fairly active labyrinth before operation. Fortunately many of the patients submitting to operation have but little vestibular function on the affected side and the post operative reactions are proportionately less severe. It is not uncommon when there is but little pre operative function to find the patient lying on his back propped up with pillows and reading the paper the day after the operation. We have found that the younger patients of both sexes tend to suffer from difficulty in micturition for the first two days after operation and in six cases administration of doryl or catheterization was necessary. In only two cases has there been any evidence of function after the operation, either cochlear or vestibular. Both of these were cases in which an attempt was made to drain the sacculus. In the first function slowly faded away until the labyrinth was dead and in the second in which there was some doubt as to whether the operation had been properly carried out, function remained. The following tables have been drawn up to show the effect of the operations on the principal symptoms

TABLE I

	Sex		Age		Duration of symptom	
	Male	Female	Under 40	Over 40	Under 2 years	Over 2 years
Improved	29	19	15	33	19	29
Not improved	4	—	1	3	2	2
Total	33	19	16	36	21	31

TABLE II

	Operation	Vertigo			Tinnitus			Hearing		
		Improved	Not improved	No record	Improved	Not improved	No record	Improved	Not improved	No record
A	Canal opened (8)	7	1	—	4	3	1	2	5	1
B	Canal excised (32)	31	1	—	16	14	2	9	21	2
C	A or B plus alcohol (10)	8	2	—	2	7	1	—	10	—
D	Sacculus incised (2)	2	—	—	1	1	—	—	2	—

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III

Vertigo	Tinnitus	Hearing	General State	At Work
Slight constant	Worse	Better	Improved	Light Household
Better 1 year Returned	Worse	Worse	Worse	No
opposite direction				
Abolished	No record	Unchanged	Improved	No
Returned after 6/12	Unchanged	Unchanged	Unchanged	Formerly bedridden
Slight	Improved	Unchanged	Improved	Now up and about
Slight when tired	Improved	Unchanged	Improved	Yes After 2/12
Abolished	Improved	Not noted	Improved	
Abolished	Improved	Better	Improved	Yes
Slight	Unchanged	Unchanged	Improved	
Abolished	Abolished	Better	Improved	
Abolished	Abolished	Better	Improved	Yes after 5/12
Slight when tired	Improved	Unchanged	Improved	Yes
Better 2 years Returned	Worse	Worse	Worse	No
opposite direction				
Slight when tired	Unchanged	Unchanged	Improved	Yes
Abolished	Improved	Better	Improved	Yes after 2/12
Abolished	Unchanged	Better	Improved	Yes after 1 1/2
Abolished	Improved	Unchanged	Improved	
Abolished	Abolished	Unchanged	Improved	
Abolished	Improved	Unchanged	Improved	Yes after 6/12
Slight on movement	Unchanged	Unchanged	Improved	Yes
No record	No record	No record		
No record	No record	No record		
Slight when noisy	Improved	Unchanged	Improved	Yes limited after 18/12
Slight Momentary for 1 year	Improved	Better	Improved	
Momentary	Improved	Better	Improved	Yes after 10/52
Abolished	Unchanged	Unchanged	Improved	Yes after 1/12
Abolished	Improved	Unchanged	Improved	Yes after 2/12
Slight	Unchanged	Unchanged	Improved	Yes Light duties
Slight occasional	Unchanged	Occasionally distorted	Improved	Yes after 18/12
Slight occasionally	Improved	Better	Improved	Yes
Slight occasionally	Unchanged	Unchanged	Improved	
Very slight occasionally	Unchanged	Better	Improved	Yes after 6/52
Abolished	Improved	Unchanged	Improved	Yes after 5/52
Abolished	Unchanged	Better	Improved	Yes after 7/52
Slight Frequent	Unchanged	Unchanged	Improved	Yes after 6/12
Slight occasionally	Improved	Unchanged	Improved	Yes after 9/12
Abolished	Unchanged	Unchanged	Improved	Yes after 2/12
Slight constant	Unchanged	Unchanged	Improved	Yes after 6/12
Slight on movement	Improved	Unchanged	Improved	Yes after 4/12
Slight occasionally	Unchanged	Unchanged	Improved	
Abolished	Unchanged	Unchanged	Improved	Yes after 2/12
Unchanged	Unchanged	Worse	Unchanged	No
Slight on movement	Improved	Unchanged	Improved	Yes after 3/12
Abolished	Abolished	Unchanged	Improved	Yes after 6/52
Abolished	No record	Unchanged	Improved	Yes after 2/12
Slight occasionally	Unchanged	Unchanged	Improved	Yes after 3/12
Slight constant	Unchanged	Unchanged	Improved	No
Slight occasional	Unchanged	Unchanged	Improved	Yes after 2/12
Abolished	Unchanged	Unchanged	Improved	Yes after 6/52
Abolished	Improved	Unchanged	Improved	Yes after 10/52
Abolished	Improved	Unchanged	Improved	Yes after 1/12
Abolished	Improved	Unchanged	Improved	Not yet

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TABLE

No.	Name	Date	Sex	Age	Side	Duration years	Operation	In Hospital days	Post operation function
1	E.J.	24.2.38	F.	47	L.	2	Canal opened	43	0
2	D.D.	30.3.38	M.	27	L.	2½	Canal opened Alcohol	21	0
3	F.H.	3.8.38	F.	35	R.	4	Canal opened	15	0
4	A.S.	11.8.38	M.	46	L.	½	Canal opened	18	0
5	L.S.	13.8.38	F.	40	R.	5	Canal opened	15	0
6	G.R.	27.10.38	F.	40	R.	7	Canal opened	15	0
7	M.C.	9.11.38	F.	39	L.	¾	Canal opened	18	0
8	J.H.	9.11.38	M.	49	R.	2	Canal opened	16	0
9	B.P.	30.11.38	F.	57	L.	½	Canal opened	10	0
10	S.L.	18.1.39	F.	59	L.	1½	Canal excised	15	0
11	G.D.	20.3.39	M.	42	R.	17	Canal excised	41	0
12	A.K.	12.4.39	F.	56	R.	2	Canal excised	13	0
13	H.B.	7.4.39	M.	53	R.	5	Canal excised	11	0
14	R.H.	20.4.39	F.	47	L.	20	Canal excised Alcohol	24	0
15	J.K.	24.4.39	M.	55	R.	5	Canal excised	13	0
16	E.R.	11.5.39	M.	37	R.	1½	Canal excised	8	0
17	A.S.	24.5.39	M.	45	L.	4	Canal excised	10	0
18	D.D.	27.5.39	F.	48	L.	7	Canal excised Alcohol	22	0
19	F.L.	18.11.39	F.	59	R.	3	Canal excised	18	0
20	E.A.	2.1.40	F.	63	L.	7	Canal excised Alcohol	20	0
21	R.B.	1.5.40	M.	43	L.	6	Canal excised	23	0
22	M.M.	21.6.40	F.	27	L.	3	Canal excised	21	0
23	W.C.	6.7.40	M.	66	L.	4	Canal excised	19	0
24	W.C.	2.8.40	M.	42	R.	½	Canal excised	18	0
25	J.M.	19.10.40	M.	34	L.	4	Canal excised	18	0
26	D.K.	21.10.40	M.	18	R.	1	Canal excised	16	0
27	W.S.	4.11.40	M.	53	R.	2	Canal excised	24	0
28	E.P.	4.12.40	M.	43	R.	2	Canal excised	—	0
29	V.T.	14.12.40	M.	43	L.	5	Canal excised	19	0
30	R.H.	26.3.41	F.	54	L.	2	Canal excised	24	0
31	E.L.	2.4.41	F.	45	L.	½	Canal excised	52	0
32	H.H.	4.6.41	M.	42	—	1½	Canal excised	7	0
33	G.S.	4.6.41	M.	33	R.	1	Canal excised	31	0
34	G.A.	17.9.41	M.	38	R.	4	Canal excised	14	0
35	A.F.	22.10.41	M.	33	R.	1	Canal excised	50	0
36	E.T.	5.11.41	F.	32	R.	2	Canal excised	13	0
37	B.C.	12.11.41	M.	57	L.	1½	Canal excised	10	0
38	A.T.	19.11.41	M.	41	L.	4	Sacculus incised	10	Slowly abolished
39	W.L.	12.12.41	M.	56	L.	1½	Canal excised	22	0
40	E.McC.	17.12.41	M.	59	R.	4	Canal excised	19	0
41	H.P.	28.1.42	M.	52	R.	1	Canal excised	13	0
42	R.P.	25.2.42	M.	54	L.	½	Canal excised Alcohol	13	0
43	F.D.	4.3.42	M.	25	R.	3	Attempted sacculus incision	10	Not abolished
44	M.B.	18.3.42	F.	46	L.	3	Canal excised Alcohol	23	0
45	C.F.	18.3.42	M.	47	R.	½	Canal excised Alcohol	17	—
46	P.N.	6.4.42	M.	37	R.	1	Canal excised	29	0
47	F.H.	30.9.42	M.	61	L.	1½	Canal excised Alcohol	34	0
48	M.B.	14.10.42	F.	37	L.	1	Canal excised	27	0
49	F.W.	25.11.42	M.	33	L.	2	Canal excised Alcohol	15	0
50	A.B.	20.1.43	M.	60	R.	¾	Canal excised Alcohol	23	0
51	A.C.	7.4.43	M.	59	R.	½	Canal excised	14	0
52	P.C.	21.4.43	F.	38	L.	3	Canal excised	30	0

The Treatment of Ménière's Disease

As regards operative treatment, we have found that opening the endolymphatic space in the manner described is sufficient to abolish function in the labyrinth and that this procedure is quite safe and is not followed by any untoward results

We recommend it for those cases of Ménière's disease with marked deafness or distortion on the affected side which do not respond to some form of conservative treatment

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CLINICAL RECORDS

FRACTURE OF THE SKULL—FOLLOWED BY LATE OTOGENIC MENINGITIS

By ALFRED B. ALEXANDER (London)*

IN the early hours of the morning of January 6th, 1943, a seaman, aet. 38, was injured in a road accident. No details are available. In an unconscious state, he was admitted to a nearby hospital, and as far as can be ascertained he remained unconscious for three to four hours. He was then transferred to a R.N. hospital, on admission to which he was found to be quite rational but drowsy; he complained of severe headache and he vomited repeatedly. There was retrograde amnesia for a period of six hours previous to the accident; his general condition was satisfactory and his pulse rate was 64. There was bleeding from the left ear and from the nose and extensive bruising in the region of the upper lip and the eyes. The left auditory meatus was found to be filled with blood and clot. The drumhead showed a small, central, slit-shaped perforation near the umbo. X-ray on admission (Fig. 1) showed a fracture line extending from the left external auditory meatus upwards and backwards through the squamous portion of the temporal bone to the parietal squame with a double contour in part of its course. The posterior branch of the middle meningeal artery was crossed by the fracture.

Throughout the next day intermittent bleeding from the left ear continued. His mental condition was blurred and he still complained of headache, but there was no more vomiting. Forty-eight hours from the accident (8.1.43) the bleeding from the ear stopped. The pulse rate was maintained between 50 and 60 and there were no localizing abnormal signs on full examination of the central nervous system. His general progress was reported satisfactory but he continued to have headaches. On the eighth day after the injury (14.1.43) sero-sanguinous discharge appeared in the left meatus. Fourteen days after the injury the left ear was still discharging and by the twenty-second day the discharge was profuse and frankly purulent. His temperature and pulse remained normal. The headaches had ceased and the patient was allowed up in a chair.

Examination of the aural discharge showed Gram positive cocci. Culture: *Staphylococcus aureus*. Coagulase test: Positive.

On the thirty-fourth day after the accident the patient was transferred to the Ear, Nose and Throat Unit of the Southern Hospital. By this time he was a patient recovering from a severe head injury and suffering from acute post-traumatic otitis media of the left ear of approximately twenty-six days' duration. He stated clearly that his ears had always been healthy prior to the accident. The left ear was discharging in fair quantity pus of a muco purulent

* From the Ear, Nose and Throat Unit of the Southern Hospital.



FIG 1 X ray on admission—shows fracture line



FIG 2 X ray 30 days after operation Shows large skull defect 6.5 x 6 cm
Arrow indicates small fissure part of the original fracture line

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character Bacteriological culture showed a good growth of *Staphylococcus aureus*. The drumhead was red but no perforation could be seen. On the floor of the meatus well in front of the tympanic membrane was a lacerated area and a small granulation. During the following week the otitis appeared to subside gradually. The discharge decreased and the drumhead became grey-red, showing radial injection. The short process became visible. Very slight aural discharge was now his only complaint. Temperature and pulse rate were normal. He was allowed up and about and was quite well, taking a part in the communal life of the up-patients of the hospital. There was nothing remarkable in his general demeanour when on the afternoon of February 16th (41 days after the injury) he complained of severe headache and earache. His temperature during the night was 101° , the next morning the patient had a rigor and a temperature of 104° . He was confused, restless, vomited and was incontinent. He had a slight hæmorrhage from the left meatus, epistaxis and some nuchal rigidity. The pupils were equal, Babinsky's sign negative. Lumbar puncture revealed a faintly turbid fluid with 25 Polymorph WBC and 125 Lymphocytes per cm. A few positive cocci were present in the gram stained specimen. Culture showed no growth. Sulphapyridine was immediately given intravenously, and the patient, by then deeply unconscious, was operated on the same afternoon.

The left mastoid was exposed in the usual way. The pneumatic system of the mastoid process was well developed. There was little sign of disease in the air cells which were lined with relatively normal mucous membrane. Only close to the antrum was there some granulation tissue. The antrum was opened and access widened in the usual way. The tip of the mastoid was denuded of its air cells and the sinus was exposed about one inch above the mastoid tip. The sinus plate was intact, but the sinus itself was covered with granulations. Exposure downwards, after a few strokes of the gouge, reached normal sinus wall just above the level of the tip of the mastoid. Upwards, the changes of the sinus wall became obvious and it was apparent that the sinus was thrombosed.

Before engaging in the upwards exposure of the sinus, the dura of the middle fossa was explored above the tegmen antri. A greyish-black blood clot partly adherent to the dura was immediately obvious. It extended forward towards the region of the zygoma root, but normal dura could be reached above the zygomatic process itself.

The 'meningitis operation' was then carried out, i.e. the bony ridge between the middle and posterior fossae was removed. The clot could now be seen to be extensive and for complete exposure of the clot free removal of the squame of the temporal bone was necessary. The original fracture line traversing the squame of the temporal and parietal bone, served as the guiding line. The transverse sinus was then fully exposed. It was found to be a firm thrombosed cord and only at about 3 cm. lateral to the Torcular could normal wall be reached. The clot and the thrombosed sinus were in direct contact and it appeared therefore that infection of the sinus had originated from the direct contact between the clot and the sinus. The operation was completed by exposing normal dura all round the clot which extended over an area comparable in size to the palm of a man's hand. The wound was dusted with

Alfred B. Alexander

powdered Sulphathiazole and loosely packed with dry wool wicks. Two stitches were used to approximate loosely the skin flaps.

Ten hours after the operation the patient regained consciousness and was rational; pulse rate 100, temperature 99.8. Lumbar puncture 48 hours after operation showed a clear, colourless fluid containing 8 polymorph W.B.C. and 42 lymphocytes per cm. No organisms were found and the culture was sterile. Sulphathiazole was continued for five days. The total Sulphonamide administered was 27 gr. The blood Sulphonamide estimated twenty-four hours after the operation was found to be 8 mgr. per cent. An intravenous glucose saline drip was maintained for thirty-six hours. Two days after the operation (19.2.43) the wound was redressed. There was practically no purulent discharge and the wound was loosely repacked. The temperature was 99, the pulse rate 100. Lumbar puncture on the fifth day showed a clear fluid with only one cell per cm.

The further post-operative course was uncomplicated and uneventful. The wound was redressed every other day and by the sixteenth day after operation the external canal was quite dry. But hearing was poor. With Eustachian catheterization the hearing subsequently improved and at the end of May he heard accentuated whisper at eight feet distance. On 4.5.43 the patient was discharged fit for duty.

Comment. The march of events in this case is interesting and unusual. A fracture of the base of the skull results in rupture of the posterior branch of the middle meningeal artery; an extra dural hæmorrhage develops. The associated ruptured drumhead lays the tympanic cavity open to infection; post-traumatic acute otitis ensues and becomes manifest a week after the injury. Fractures of the base of the skull followed by acute otitis are not uncommon and otologists find that such post-traumatic infection not uncommonly leads to post-traumatic mastoiditis. Operating on cases of this type, one now and again finds clots of varying sizes and in varying stages of organization between the tegmen and the dura. Where such a clot is found in the course of the mastoid operation, its presence, generally, has not manifested itself clinically. Further, even if its circumference is not fully exposed, and part of the clot has to be left behind, covered by bone, it does not, as a rule, produce any disturbance in the post-operative course. The unusual feature of this case is that meningeal symptoms were suddenly produced as the clot became infected while the mastoid cellular system remained practically unaffected. It is rare for the fracture hæmatoma to become infected as it did in this case. Especially rare is it, and I have not come across a similar recorded case, for the hæmatoma to become infected after a lapse of almost six weeks.

The injection of the hæmatoma in this case produced two sets of signs—meningeal and septicæmic. First, and with dramatic suddenness there appeared signs of acute irritation of the meninges and the infection was confirmed by the cerebrospinal fluid findings. Secondly, the walls of the sinus became infected and rigors followed. The operation—an extensive one—exposed the whole of the diseased area of dura and sinus and was followed by the regaining of consciousness within a few hours—despite the fact that the patient had been deeply unconscious for quite twelve hours previously. The Sulphonamides

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almost certainly contributed to the rapid clearing of the cerebrospinal infection and to the uneventful post-operative course.

This case well illustrates the contention of a number of otologists that cranial injuries with ear discharge or symptoms have the Sword of Damocles suspended over their heads and require careful continued observation. In this recorded case even after six weeks, within a night, the patient's condition became one of grave seriousness. The question may thus well be asked, should this patient have been operated on prior to the onset of the meningeal symptoms. In my experience, acute traumatic otitis in itself is no indication for surgical interference. *Indiscriminate surgery here is just as harmful and of as little value as indiscriminate surgery in the early stages of the acute non-traumatic otitis.* If the post-traumatic otitis develops into mastoiditis, operation of course must not be withheld, but sufficient time should always be allowed for the otitis to clear up without surgical interference; and it must be remembered that the average duration of an acute suppurative otitis media is twenty-one days. The time to operate on an acute mastoiditis is the third or fourth week after the onset of the ear symptoms. Earlier operation may be forced because of the onset of intra-cranial complications, but we then operate for the intra-cranial disease, and not for the mastoiditis.

It is well to ask oneself whether a fracture of the skull in a patient already suffering with a chronic middle-ear disease is not an indication for immediate surgery; for obviously the blood clot is in continuity with the infected tympanic cavity. Even so, it is my experience that it is better to await developments in such cases; there is definitely time to wait for surgery. If an acute exacerbation ensues, revealed by pulsating pus, recrudescence of marked ear-ache, a rise in temperature—or if intra-cranial signs appear, surgical interference becomes an urgent necessity. The radical mastoid operation, aiming at the complete elimination of all the diseased bone, is then the operation of choice. If less is done and a mere mastoid antrum drainage performed in the chronic variety, persistent otorrhœa will continue almost invariably.

One would plead that as head injuries are so often connected with ear damage, arrangements should be made for the routine examination of every such case by the otologist.

I should like to acknowledge my gratitude to Surgeon Captain R. G. Henderson, Superintendent of the Hospital.

Summary

1. A case is described showing the sudden onset of unconsciousness and meningeal symptoms six weeks after a fracture of the skull.
2. The operation is described in detail; the indications and the time for operating in the traumatic otitis media are discussed; the chronic discharging ear with associated skull fracture is considered.
3. The need for prolonged observation by the otologist of the discharging ear which follows a fracture of the skull is stressed.

A CASE OF EXTRA DURAL HÆMORRHAGE FROM THE INFERIOR PETROSAL SINUS FOLLOWING MASTOIDECTOMY

By GERALD A. MOULDEN, Major, R.A.M.C.

EXTRA dural hæmorrhage is, in the great majority of instances, due to rupture of the middle meningeal artery as a result of violence applied to the skull, usually associated with fracture, although fracture of the skull is not essential. But extra dural hæmorrhage can also be caused by rupture of the venous sinuses coincident with fracture. In this traumatic type of venous hæmorrhage the sinuses involved are either the longitudinal, the transverse, or the cavernous sinuses. Bleeding may continue to the point of cerebral compression enough to cause death, because the walls of the sinuses may not be capable of complete apposition with increasing pressure, part of the lumen having bony support.

Suggit (1943) has described a case of extra dural hæmorrhage in the middle fossa, arising from the lateral sinus, which was a sequel of cortical mastoidectomy and was fatal, and he quotes two other cases of extra dural hæmorrhage due to rupture of venous sinuses.

This paper describes a case of extra dural hæmorrhage in the middle fossa caused by erosion of the inferior petrosal sinus and following radical mastoidectomy.

Case Report

A naval officer, aged 27, was admitted on September 30th, 1943, complaining of earache, right side, for over three weeks with some discharge. He has suffered from vague abdominal pain, constipation, heavy pain in right temporo-parietal region, and giddiness on stooping. The right ear has discharged intermittently since the age of 12 years. Has lost 8-9 lb. in past month.

ON EXAMINATION

Right Drumhead: nearly complete destruction; that part which is above handle of malleus remaining, together with a small strip from umbo to inferior margin. The inner tympanic wall is white, due to epithelial desquamation; there are two granulations from beneath posterior malleolar ligament and one small granulation centrally in post-inferior quadrant. Cholesteatomatous debris is seen in front of, and above, the small process of the malleus, and some pulsation is noted here.

Tenderness is slight over the mastoid antrum and more marked along the anterior border.

No fistula symptom present.

Very slight fine nystagmus to both sides—equal.

C.N.S. Reflexes and sensation normal. No cranial nerve lesions. Optic discs normal.

Total white cells, 11,500 cu.mm. Polymorphs, 66%. Lymphocytes, 24%. Monocytes, 6%. Eosins, 4%.

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X-RAY MASTOID PROCESS

Acellular, partly sclerotic bone There is a well defined area of rarefaction, the size of a cherry, between upper and posterior aspect of petrous—suggesting considerably enlarged antrum due to cholesteatoma Sinus in anterior position, particularly in the region of the upper sinus genu Tegmen thinner than normal, anterior sinus wall seems to be normal

8 10 43 OPERATION

Endotracheal ether given by Capt V A Rogers

Very dense cortex Lateral sinus exposed at a depth of one eighth of an inch, only a quarter of an inch from the posterior meatal wall Dura was low and exposed during dissection and before antrum was reached Antrum opened by removal of posterior meatal wall On opening the antrum a square of bone $\frac{1}{2}$ in by $\frac{1}{2}$ in came away from the roof Dura was injected laterally but was under no tension although no obvious pulsation was seen it was felt to be normal (no suggestion of intra dural or cerebral abscess) The antrum was "expanded" to bean size and extended backward medial to the lateral sinus Granulations were curetted out of an extension into the Citelli angle Bridge was removed when opening antrum Some bleeding occurred during the clearing of necrotic bone in the region of the lower part of sinus (between sinus and perifacial region) This was easily controlled by the pressure of a swab and did not recur during the operation Malleus, tympanic remnants and granulations removed Plastic flap cut (Ballance) Sulphonamide Vaseline gauze Sutures The meatal walls formed a flap to cover the greater part of the uncovered dura

9 10 43 Morning temperature, 99 pulse, 84 Patient feels well no headache Some discomfort in the evening Morphia gr $\frac{1}{4}$ ordered and given Evening temperature, 98, pulse, 80

10 10 43 Slept until 04 00 hours woke with severe pain Bandages released to relieve pain At 05 00 hours patient became worse Breathing stertorous Colour very poor Pulse rate=54 06 00 hours, pulse rate=68

Right pupil dilated Left knee jerk absent Papilloedema present

Dressings taken down Pack removed Much venous bleeding Packed again

07 15 hours Wound re opened Bleeding from depths of wound in region of Trautmann's triangle Lateral sinus further uncovered and pack inserted Bleeding stopped

Dura covered with clot and pulsating Part of squame removed extra dural clot seen

Patient died at this point

Post-Mortem Examination

EXTERNAL INSPECTION

Pupils dilated, right more than left No post mortem rigidity or lividity seen Skin and visible mucous membranes very pale Wound of operation (radical mastoidectomy) behind the right ear Hæmorrhage from the right ear

INTERNAL EXAMINATION

Skull. Operative defect present; mastoid exenterated, middle-ear structures absent, defect of tegmen and adjacent portion of squame. Forward and superficial position of upper genu of lateral sinus—intact. The dura over right parietal bone in right medial fossa detached from the skull by extra dural hæmorrhage. The blood is clotted, adherent to the skull in parietal region and os petrosum area of sinus petrosus inferior, about 1 cm. from the jugular bulb. The bone here is necrotic, the wall of sinus eroded, bleeding point covered by adherent plug. The clot is partly organized. The brain is compressed by a hæmorrhage. Pia mater very congested, all vessels engorged by fluid dark blood.

The brain tissue of yellowish colour, soft, œdematous. The ventricles slightly enlarged by internal hydrocephalus.

Thorax. Lungs, voluminous, œdematous. Heart, dilation right side.

Abdomen. Anæmia of viscera.

SUMMARY OF FINDINGS

Extra dural hæmorrhage right side. Chronic otitis media. Necrosis of os petrosum. Erosion of right sinus petrosus inferior. Mastoidectomy. Congestion of meninges. Œdema cerebri. Hydrocephalus internus. Compression of brain.

(Signed) J. J. CHVAPIL, Capt., R.A.M.C.

Comment

The signs of cerebral compression in this case manifested themselves with dramatic suddenness: within two hours from the onset of symptoms, forty hours after the operation, the patient was comatose.

The bleeding from the inferior petrosal sinus took place mainly into the mastoid cavity. But the bleeding did not show itself on the dressings because the vaseline gauze had occluded the meatal orifice. Instead of soaking the dressings and appearing through the bandages, the blood stripped up the dura of the middle fossa in the temporo-parietal region through the defect of the tegmen. If some form of drainage had been employed the bleeding would have been conspicuous and demanded early treatment. Death occurred at the point when the extra dural clot was seen and only partially uncovered.

In a case of radical mastoidectomy in which the dura of the middle fossa is exposed, dressing of an occlusive nature should be avoided. The virtues of vaseline gauze could still be used if a tube be inserted first to the region of the tegmen defect and the gauze packed around it.

I am indebted to Capt. J. J. Chvapl, R.A.M.C., for the Post-mortem report, and to Lieut. J. Munk, R.A.M.C., for the Radiological findings.

My thanks are due to the Director of Medical Services, Middle East Forces, and to Lieut.-Colonel P. Carney, R.A.M.C., for permission to publish this paper.

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SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

May 7th, 1943

President—F. C. ORMEROD, F.R.C.S.

The Deafness of Ménière's disease

A. J. WRIGHT

IN order to gain a broad picture of the degree of deafness met with in this disease I made an analysis of the records of 100 cases.

The degree of hearing is described under the terms good, useful and bad.

By good hearing is meant perception for the whispered voice at 15 feet ; useful hearing, perception for the conversation voice at 6 feet or more ; bad hearing, no perception for the conversation voice at 6 feet.

It was surprising to find on taking the group of 100 cases as a whole that in only 8 of them was the hearing bad in both ears. Of the remainder 41 retained good hearing in one ear, 7 good hearing in both, and the remaining 44 retained useful hearing in at any rate one ear.

Of the cases with good hearing in both ears at the time of examination the complaint had existed for periods of three months, four months, two, three, four, fifteen and nineteen years respectively.

It would therefore seem that this disease only produces a high-grade hearing defect in about 8 per cent. of cases while about a similar proportion may be expected to retain good hearing in both ears over long periods. Of the remainder about an equal number may be expected to retain good or useful hearing in at any rate one ear.

From this analysis cases would seem to fall into two groups, those with a unilateral and those with a bilateral onset. In this series 72 were of unilateral onset and 28 of bilateral. The smaller group seems to present certain special features. Thus the outlook from a hearing point of view seems to be relatively bad, seven of the total of eight cases recorded as bad occurring in this group. In addition these bilateral cases seem to be most resistant to treatment. In two of them in which the cerebrospinal fluid was investigated an increase in protein content was observed. This finding would perhaps suggest an associated derangement of perilymph, endolymph and cerebrospinal fluid.

From the point of view of employment of any destructive operation for the relief of the vertigo, it is of importance to estimate the probability of a serious degree of loss of hearing taking place in the future in the unoperated ear.

I found that of the 72 cases with a unilateral onset in only 13 did the other ear become affected later. The longest interval preceding this involvement was twenty-five years, the shortest eight months, and in 9 of the 13 cases

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the period was greater than ten years. Actually only one of these 13 cases did not retain useful hearing. Thus the chance of an individual retaining good hearing over a long period in a case of unilateral onset would seem to be good.

From a clinical standpoint, therefore, Ménière's disease does not frequently produce a high grade deafness in both ears; when it does do so it is usually in cases in which the complaint is definitely bilateral in onset; where the complaint is decidedly unilateral there is a strong probability that the other ear will retain useful hearing in the future.

Observations on the caloric tests of vestibular function

T. A. CLARKE

In September 1942, Cawthorne, FitzGerald and Hallpike published three papers under the general title "Studies in Human Vestibular Function". It is with certain theses therein contained that these remarks are concerned.

Labyrinthine tonus.—Cawthorne, FitzGerald and Hallpike put forward the hypothesis that the utricle is the seat of origin of the continued labyrinthine tonus, the interruption of which, e.g. by labyrinthectomy, or the diminution of which in disease, is responsible for spontaneous nystagmus or the phenomenon of directional preponderance of nystagmus to which they draw attention.

It would seem that their argument is based upon Ross's investigation of action currents in the VIIIth nerve of the frog, recording that certain parts of the nerve, inactive during rest, were active during rotation; and also based (perhaps fundamentally) upon McNally and Tait's experiments also upon the frog, finding that ablation of nerve impulses from all the labyrinthine parts except the utricle produced no change of posture, whereas ablation of the utricle produced gross change of posture.

Cawthorne, FitzGerald and Hallpike themselves draw attention to the danger of making assumptions as to human vestibular function from findings in one or another animal—notably for example in the case of the pigeon (Ewald's pneumatic hammer experiments), the frog (unidirectional sensitivity of the canals to endolymph flow), and the dogfish (Löwenstein and Sand's finding of tonic impulses proceeding from the canals).

Support for the argument that the external canal is not concerned in continued labyrinthine tonus is perhaps found in the pathological material provided by the authors. Were the external canal so concerned, unilateral paresis of recent origin would inevitably be associated with the occurrence of directional preponderance of nystagmus. But external canal paresis without associated directional preponderance of nystagmus is recorded even in cases where the short duration of labyrinthine symptoms suggested recent onset of the canal paresis.

The balance of evidence available would seem to suggest that the external canal is not concerned in the origin of the constant labyrinthine tonic influence. There does not, however, appear to be any evidence which would exclude the superior and posterior canals from being so concerned; these canals are relatively less sensitive to endolymph flow than is the external canal (Bárány);

in many ways they are synergic with the utricle, and they may well be concerned with the latter in continued labyrinthine tonus. For convenience of nomenclature, it is probably well to agree with Cawthorne, FitzGerald and Hallpike, and to speak of utricular tonus and of utricular lesion as being the vestibular cause of a directional preponderance of nystagmus. But that the utricle alone is concerned is not proved.

Ewald's law —The results of hot and cold caloric stimulation, using approximately equal thermal stimuli, both in normal subjects and in patients before and after unilateral labyrinthectomy, clearly demonstrate that in the human external canal ampullopetal endolymph currents are not substantially (if at all) more effective than ampullofugal currents. Cawthorne, FitzGerald and Hallpike, by their strikingly simple experiments have clearly shown that Ewald's law relating to this is not applicable to the human external canal, interference with the normal balance of the continued tonus of the two labyrinths provides the explanation necessary of the phenomena following unilateral labyrinthectomy.

Effects of caloric irrigation —If, however, conclusions are to be drawn from caloric tests as to labyrinthine physiology, or if pathological lesions are to be localized by such tests, certain considerations are first requisite.

Cawthorne, FitzGerald and Hallpike report that in their experiments ampullofugal endolymph currents in the external canal produce nystagmus normally (i.e. in 80 per cent of their cases) of longer duration than ampullopetal currents—i.e. that cold irrigation is more effective than hot, the tests being made in the ampulla up (or face up) position. This finding is in my view to be explained by the fact that equivalent thermal stimuli were not employed. The water in the storage can was in each test regulated to 7°C above and 7°C below 37°C . Owing to cooling in the can and in the delivery tubing, the water actually reaching the ear would be 5.7°C above, and 7.5°C below 37°C —in other words the cold tests as applied afforded a substantially greater thermal stimulus than the hot.

A closer approximation to equal thermal stimuli would be obtained if the water in the storage can were adjusted to 44°C and 31.8°C , but this would require to be adjusted for each series of tests, depending upon the size of the can, the length and thickness of the delivery tubing, the rate of flow of the water and the temperature of the room in which the tests are performed. Moreover one would think that not 37°C but the ascertained internal temperature of each patient must determine the mean point in each case.

Considerable importance is to be attached to the determination of the normal relationship between the responses to cold and hot irrigation (C/H ratio) because from variations from an established normal we may learn to draw conclusions as to pathology and because the establishment of such a normal would remove one variable factor from our present caloric results and would thus result in greatly increased accuracy in their analysis.

Using equivalent thermal stimuli I have found that nystagmus after cold irrigation commonly is of slightly shorter duration than that after hot irrigation. The difference is small, and may well not indicate a differential sensitivity to the direction of endolymph flow but be peculiar to the caloric test, the crista being less sensitive when cooled and more sensitive when warmed.

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Extra-canalicular effects.—Before conclusions as to the function of the external canal can be drawn from caloric tests, the possibility of results of irrigation other than mere canal stimulation must be considered. It may well be that cold and hot irrigations depress or stimulate the normal tonic impulses proceeding from the labyrinth of the irrigated ear. This was the explanation first provided to account for the phenomena following caloric stimulation, but was subsequently abandoned in view of the overwhelming evidence of thermal currents in the external canal. These currents must be the dominant factor, but if we are to base upon accurate caloric tests conclusions as to the physiology or pathology of the intralabyrinthine parts, we must consider the possible existence of other factors. Accepting the presence of continued labyrinthine tonus, which, if unbalanced, will produce spontaneous nystagmus or will increase or decrease nystagmus resulting from canal stimulation; it is then entirely to be expected that cooling of the labyrinth will decrease this tonus, and that warming of the labyrinth will increase this tonus.

The result of this would be to increase the nystagmus resulting from canal stimulation in the case of both cold and hot irrigation, if the external canal is in the ampulla-up position (i.e. the patient in the face-up position). In the ampulla-down (face-down) position, however, the effect would be to decrease the nystagmus resulting from canal stimulation by both cold and hot irrigation.

I have examined eight patients in the manner suggested, using assumed equivalent thermal stimuli, and testing in the ampulla-up and ampulla-down positions. The tests are not easy of performance, and, while efforts have been made to secure equivalent conditions by affording similar fixation for the eyes and similar illumination, it has not been possible to avoid that congestion of the head and that muscular (and nervous) strain which must result in greater or less degree from the adoption of the ampulla-down position. That such factors may affect the duration of nystagmus is likely. Lorenté de Nô has stated that merely to tweak the tail of a rabbit which is the subject of experiment is to affect the duration of nystagmus, and de Kelyn and Versteegh are quoted by him as showing that irritation of the nose has a similar effect.

If these considerations are to be kept in mind, it may be stated that the results in the eight cases so tested by me show that the duration of nystagmus after caloric irrigation is consistently less in the ampulla-down than in the ampulla-up position, suggesting that cold irrigation may depress the normal tonus of the labyrinth, and warm irrigation increase it.

Analysis of results.—An accurate test demands accurate analysis. Consideration must then be given as to the margin which must be allowed for variations within the normal and for observational or experimental error.

In the diagnosis of pathological lesions Cawthorne, FitzGerald and Hallpike attach importance to the appearance of "patterns" on analysis of their familiar diagrams (calorigrams). These calorigrams are readily appreciated, but personally I have found it easier for purpose of analysis to record the results of the tests and the process of analysis in tabular form. Below appears a calorigram of an illustrative case, in diagrammatic and tabular form.

Multiple manipulations of the figures are proper to determine the presence of "pattern reactions". Lines 1 and 2 (or 3 and 4) may be added to (or

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subtracted from), to compensate a variation in the Cold Hot ratio Lines 1 and 3, or 2 and 4 may be added to, or subtracted from, to compensate a canal paresis Lines 1 and 4 (or 2 and 3) may be added to, or subtracted from, to compensate a directional preponderance of nystagmus caused by (in the absence of cerebral lesion) an alleged utricular paresis

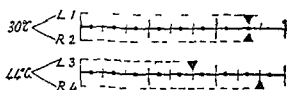


FIG 1

TABULAR EXPRESSION AND ANALYSIS OF CALORIC TESTS

	(a)	(b)			(c)			(d)			(e)			(f)	(g)
	Duration of nystagmus Result	C>H +10			Rt ext canal +20			Rt utricle +20			Dis crepancy 20			Nystag mus	Vertigo
1	30°C {	L 2 30		2 30	20	2 50		2 50		2 50		2 50		Mod	Slight
2		R 2 30		2 30		2 30	20	2 50		2 50		2 50		Mod	Slight
3	44°C {	L 1 40	10	1 50	20	2 10	20	2 30	20	2 50		2 50		Fine	Nil
4		R 2 40	10	2 50		2 50		2 50		2 50		2 50		Mod	Slight

Column (a) Records Duration of nystagmus

Column (b) Records the excess duration of the cold over the hot reactions

Column (c) Records the excess response of the right external canal as compared with the left

Column (d) Records the directional preponderance of nystagmus in terms of influence of the right utricle relative to the left

Column (e) Records the discrepancy persisting after adjustment for the known factors (Columns (b) (c) (d))

Columns (f) and (g) record a description and comparison of the nystagmus and vertigo elicited in each test

It will be seen that the possible manipulations are numerous, all must be practised in one case if necessary to achieve an approach to symmetry of the reactions

It is clearly possible to obtain a pattern reaction in every calorigram with rare exceptions. Such an exception would be the recording of exactly equal duration of nystagmus in all four tests or the finding of three equal reactions with one only at variance. In manipulating the figures to determine 'patterns', it is proper to vary simultaneously any combination of two figures but never one figure only. Such a variant figure must remain variant with the other three. This persistent difference may be described as a discrepancy, for our present theory and present knowledge permit no explanation. Such a discrepancy is also frequently found in cases where the figures have been adjusted in correction of the pathological patterns noted—the adjustment has secured an approach to symmetry but one figure remains at variance.

The occurrence of these discrepancies is of great importance. They have been numerous in the seventy subjects whom I have examined, they occur in the published cases of Cawthorne, FitzGerald and Hallpike.

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nystagmus is an unreliable indication of the vestibular function, but from the average of a number of cases a conclusion may be drawn

In fifty normal controls Cawthorne, FitzGerald and Hallpike record that less than 20 per cent showed nystagmus lasting more than 2 min 10 sec. Their recorded cases of Ménière's disease showing "canal paresis" only—i.e. excluding cases exhibiting directional preponderance, which would tend to prolong the nystagmus, excluding also three cases described by the authors as showing canal paresis only, but which in my view show also directional preponderance (Cases 31, 34 and 39)—these cases of "canal paresis" only show nystagmus lasting more than 2 min 10 sec more than twice as often as do the normal controls, in 12 of the 26 cases. If cases with clear-cut paresis are excluded the percentage of the remainder with this excess reaction is of course very much higher.

The symptoms of Ménière's disease are now coming to be accepted as being due to an asymmetrical vestibular paresis. While this is undoubtedly in many cases true, the above figures would suggest that in a proportion of cases there is still room for a diagnosis of local hypersensitivity, or, perhaps, of a lack of central inhibition, as being responsible for the symptoms.

DISCUSSION

Squadron-Leader G. H. BATEMAN, R.A.F.V.R., said that in the discussion so far as it had proceeded no mention had been made of the superior and posterior canals. He wondered whether Mr. Hallpike considered that the external canal had a preponderating physiological effect or whether all the canals had equal, though different, effects, and the external canal was discussed only because it was the easiest one to investigate.

Mr. H. V. FORSTER said it had been mentioned that sensitivity might be a cause of vertigo and in America he believed that allergy had been blamed for this symptom. Torsten Skoog of Lund, though aware that brain tissue was resistant to sensitization, had claimed that a sharply defined area in the medulla was not resistant (*Acta otolaryng, Stockh*, 1937, xiv, 365). He thought that this result of his experimental work was of interest to those seeking an explanation for certain attacks of vestibular vertigo, because of the proximity to the area of the vestibular nuclei. Mr. Hallpike's researches had demonstrated pathological changes in the end organ—the labyrinth—but did he think that changes in the central nervous system might also be at fault in some cases?

He believed that Thornval had once expressed the view that symptoms of vestibular vertigo might arise from disturbances in the medullary nuclei.

In the treatment of Ménière's syndrome he had found bulbocapnine useful, particularly during the acute attack.

Mr. HALLPIKE, in reply, said, with regard to Major Clarke's remarks, he was indebted to him for examining this work with such care and skill.

With regard to the question asked about the superior canals, the part played by the vertical canals was not known. As to the explanation of the greater effect of the cold stimuli, Major Clarke had pointed out very properly that although they had selected 30° and 44° C. respectively, it was very likely that the hot water lost heat at a greater rate than the cold in the course of

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running it in, and that this was a factor in the smaller responses usually obtained to hot stimulation.

In some of the published results the abnormalities appeared small, but he and his colleagues had pointed out that it was not only the time difference but the general amplitude which played a big part in arriving at a decision. Small time differences accompanied by big differences of amplitude of nystagmus were, they thought, significant and the cases which Major Clarke was referring to were of that kind. He would have thought that the establishment of these tests on a firm statistical basis was a matter of difficulty which could not be got over very quickly. It was important to have delicate tests of this kind.

With regard to the point made by Mr. Forster, the fact that gross changes of a constant type did occur in the labyrinth did suggest that the labyrinth was the principal seat of the disorder. There was no reason why the changes in the labyrinth should not to some extent have an allergic basis, and he had met one or two cases in which it was said very definitely that an attack could be produced by eating such food as cauliflower. But those cases were very rare.

ABSTRACTS

EAR

A device for detecting Simulated Unilateral Deafness MAJOR LOUIS K. PITMAN
(Medical Corps, Army of the United States) *Jour A M A* March 6th,
1943, CXXI, 10

The device described in this paper makes use of the stethoscope test in a new way. By interfering with the malingerer's powers of concentration it renders him helpless to carry out his purpose.

A common stethoscope is adjusted to the suspect's ears with a bell behind his back. At the fork of the stethoscope is set a two in one petcock fitted with tubes A and B. The stethoscope bell is attached to the far end of the tube A, the Bárány noise apparatus to the far end of tube B. When the handle of the petcock is moved clockwise until blocked, words spoken into the bell will be conveyed to the suspect's right ear only and the noise from the Bárány apparatus will enter his left ear. The procedure is then immediately reversed by moving the handle counterclockwise. Now the spoken words enter the suspect's left ear, and the noise his right ear. The result is that the subject is bewildered, as shown by his responses to the standard tests.

The article is illustrated.

ANGUS A. CAMPBELL

The prevention of Ear Disability in Industry DAVID A. MCCOY, M.D. (Boston)
Jour A M A, April 24th, 1943, CXXI, 17

The deafness in the 'boilermaker's ear' is relative to prolonged and repeated exposure to loud noises and particularly loud sounds of high frequency. Conversation voice varies from thirty to sixty eight decibels.

Damage to the ear canal, drum and middle ear may be caused by flying balls of hot slag or particles of welding material.

Cotton or rubber ear stoppers have been used to keep out foreign materials and will lower sound from ten to thirty decibels. The writer feels the most satisfactory ear stopper is made of plastic material. They will keep out foreign materials and will lower sound thirty to forty decibels in the high frequency range.

A plaster cast is made of each ear. The casts are transformed through a mould into an exact reproduction in transparent plastic lucite.

The article is illustrated.

ANGUS A. CAMPBELL

ŒSOPHAGUS

Lesions of the Œsophagus in Generalized Progressive Scleroderma
JOHN R. LINDSEY, M.D., FREDERIC E. TEMPLETON, M.D. and
STEPHEN ROTHMAN, M.D. (Chicago) *Jour A M A* November 20th
1943, CXXIII, 12

From a study of five consecutive cases of diffuse scleroderma it would seem that œsophageal disturbances are very common and may occur early in the course of the disease.

Abstracts

Difficulty in swallowing solids or liquids and burning pain behind the sternum are common symptoms.

Oesophagoscopy reveals oesophagitis and loss of peristalsis in the lower two-thirds, chronic ulceration with stricture formation may develop at the lower end.

The microscopic features of the granulation tissue layer show pronounced thickening of connective tissue, hyperplasia of the capillaries and a great number of eosinophils and plasma cells. The inflammatory process extends into the muscular layers.

The article is freely illustrated and has a bibliography.

ANGUS A. CAMPBELL.

PHARYNX.

Bloodless Tonsillectomy under local anæsthesia. MAJOR G. W. MOREY, M.B. (Adelaide).

The writer gives details of his method as used in more than 2,300 cases, and by which he claims that 90 per cent. of the operations are completely bloodless, while in the remaining 10 per cent. there is rarely more than an eggcupful of blood lost. It is also claimed that the time of recovery is shorter. To me the operation in the sitting up position is not new. I have, however, found that with an expert anæsthetist a general anæsthetic was preferable. However, such anæsthetists are rare, and the method of local anæsthesia described by Major Morey appears to be a very sound one.

MACLEOD YEARSLEY.

MISCELLANEOUS.

The prevention of Ear and Nasal Sinus Complications of the Common Cold.

DAVID A. DOLOWITZ, M.D., WALTER R. LOCH, M.D., HENRY L. HAINES, M.D., ARTHUR T. WARD, Jun., M.D., and KENNETH L. PICKRELL, M.D. (Baltimore). *Jour. A.M.A.*, October 30th, 1943, cxxiii, 9.

The writers conducted a controlled bacteriological and clinical study to determine the effectiveness of 2.5 per cent. sulfadiazine solution in ethanalamine (Pickrell's solution) used as a spray for the nose and throat. The object of this treatment was not to cure the common cold, but to prevent bacterial complications in the ear, nose and throat.

Without their knowledge fifty-nine nurses were placed in the treated group and forty-four in the control group. In the treated group, the nose and throat were sprayed with sulfadiazine solution eight to twelve times a day for three days, and from five to eight times a day for three additional days. The control group was sprayed an equal number of times with the solvent alone.

Bacteriological studies showed that the sulfadiazine spray did not sterilize the nose and throat, with the occasional exception of a beta hæmolytic streptococcus infection.

Miscellaneous

Some patients complained about the taste and an irritation around the external nares. One patient developed a localized sensitivity and another developed a generalized cutaneous rash.

Sinusitis and otitis media were three times as common and cough five times as common in the control group. No pharyngitis or laryngitis developed in the treated group, whereas 10 per cent. of the controls developed pharyngitis and 2·3 per cent. developed laryngitis.

ANGUS A. CAMPBELL.

OBITUARY

FREDERICK JOHN CLEMINSON

M.Chir.(Camb.), F.R.C.S.

MR. F. J. CLEMINSON died of pneumonia on the 21st of August, 1943. Notices have appeared in the *British Medical Journal* and *Lancet*, and in the *Lay Press*. If this tribute to his memory appears to come late in time, it has possibly the advantage of seeing him in something nearer to a true perspective, and the stature of the man, the surgeon, and the research worker is not thereby diminished.

Much has been written of his academic attainments. A double first in the natural sciences tripos came easily, as did other distinctions, yet left him free to make and develop innumerable acquaintanceships and many warm friendships.

From Cambridge he went to University College Hospital, graduating in 1909 and taking his fellowship three years later. As Clinical Assistant at Great Ormond Street he at once attracted attention, more especially in the treatment of children, and on this follows his appointment to the Evelina. He became aural surgeon to the Middlesex Hospital in 1921 and on this centred his main professional interest. Here he enlisted the help of his uncle, who founded in 1927 the Ferens Institute of Oto-rhino-laryngology, of which he became the first Director. He was an active member of the R.S.M. Sections of Laryngology and of Otology, was on the Council of both, and President of the latter. His contributions to the Sections were, alas, all too few, and his real worth perhaps lay in his opinions expressed at the Clinical Meetings and in the discussions. He shared in the foundation of the Collegium at Gröningen, and was one of the most active members of this Society both professionally and socially. He was as admirable an operator in the theatre as he was enthusiastic as a director and inspirer of research.

But if much can be written of his scholastic and professional attainments even more of personal value remains in the memories of all those who both knew and loved him. He was human and humane, inexhaustibly sympathetic, invariably wise and well-balanced. To lay greater stress on Clem the man than on Cleminson the surgeon is in no way to denigrate the latter, but rather, thereby, to exalt the former.

In his early death we have lost a wise, a kind, an understanding human being, as well as an alert and comprehensive intelligence.

C.P.W.

The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

October 1943

VITAMINS IN OTOLARNGOLOGY*†

By H B PERLMAN (Chicago)

IN the past decade there has been a rapid growth of interest in vitamins. This interest has not been confined to the laboratory but has rapidly spread to the medical and lay public. A great deal of specially prepared vitamins are now consumed not only under the direction of a physician but more often on the advice of the corner druggist or as the result of direct advertising. This interest in vitamins is shared by the otolaryngologist and is perhaps a natural development of laboratory research in this field. Constant search for a better understanding of many of the obscure diseases that the otolaryngologist is called upon to treat, together with a desire to follow any suggestive lead in therapy, and the constant pressure of the patient for help in relieving his illness often spurred on by unwarranted claims of advertisements and inaccurate information, has resulted in a widespread interest and use of vitamins in the practice of otolaryngology as in many other fields of medical practice.

It appears indicated to review the subject at this time in an attempt to evaluate present scientific information about the vitamins as it may relate to otolaryngology. In looking for this relationship between vitamin physiology and clinical otolaryngology, the most sound approach is to review the clinical picture of known deficiency states in man and not in the experimental animal. These vitamin deficiency diseases have occurred in outbreaks in various parts of the world, are endemic in some places, and have been reproduced in man under controlled laboratory conditions. It is safe to assume that if otolaryngological manifestations

* From the Division of Otolaryngology of the University of Chicago.

† Work done in part under a grant from the Douglas Smith Foundation of the University of Chicago.

are not found in the full blown deficiency state, they are not likely to be found in any so-called subclinical deficiency state. On the other hand, if we have otolaryngological signs in the classical deficiency states, we may be permitted the view that the presence of these signs help to define the deficiency state and when correlated with other objective evidence of the specific deficiency, these signs can be of definite importance in clinical otolaryngology. While many vitamin fractions have been identified by controlled animal experiments only a few of the vitamins have been connected with known clinical states in man. These may now be reviewed briefly.

Vitamin A deficiency produces *zerophthalmia* and *night blindness* in man. This deficiency state is endemic in some portions of the Orient. A particularly large incidence has been found in some parts of India and in the Malay peninsula. Sexually mature persons with *zerophthalmia* may have cutaneous lesions of a papular nature due to *hyperkeratosis* of the hair follicles. As many as 5 per cent. of all hospital admissions in some parts of Java are patients with *zerophthalmia*.¹ Many cases among children are seen in Latin American hospitals. Furthermore an epidemic of *zerophthalmia* broke out in Denmark shortly after the last World War.² Occasional post-mortem examinations have been made on infants and children dying with this deficiency state. In reviewing the clinical picture from reports of these cases and the post-mortem findings there is very little evidence of ear, nose or throat pathology. An occasional report of metaplasia of the bronchial and sinus mucous membrane appears in the autopsy findings.³

Vitamin B₁ or thiamine deficiency produces a disease called *beriberi*. This is endemic in certain portions of the Orient as the result of eating a diet largely confined to polished rice. The clinical picture is that of a multiple neuritis, not as isolated neuritis, and this neuritis regularly affects the nerves of the legs first—leading soon to muscular and skin atrophy. This is called the "dry type". A "wet type" is characterized by oedema and cardiac changes that may cause death. Again in the clinical and pathological reports of these cases otolaryngological signs are singularly scarce.

Nicotinic acid deficiency is endemic in some of the southern areas of the United States in the form of *pellagra*. Ulcerations in the mouth and glossitis are the principal otolaryngological signs. A dry oesophagitis with ulcers was also present in a number of the *pellagra* patients according to Dr. Fisher's report at the October 1943 meeting of the American Academy of Ophthalmology and Otolaryngology. Dermatitis, dementia and diarrhoea are the chief late signs of this disease. Often associated with this deficiency is riboflavin deficiency, another vitamin B fraction. Inflammation of the lips and rhagades about the corner of the mouth and nose appear to be its principal clinical signs. Before these symptoms

Vitamins in Otolaryngology

appear burning of the mouth, tongue and eyes have been noted in carefully studied groups of patients⁴ During the Spanish Civil War many cases of glossitis were seen These appeared to respond to vitamin B complex in the form of yeast, better than to nicotinic acid⁵ The ulcers of the tongue and oral cavity seen in nicotinic acid deficiency tend to become infected with Vincent's organisms and respond to nicotinic acid therapy⁶ Similar chronic ulcers encountered in the clinic, even when no other signs of deficiency exist, have occasionally responded to nicotinic acid therapy⁷ Other fractions of vitamin B have been identified only on experimental animals and have no clinical counterpart

Vitamin C or ascorbic acid deficiency is seen among large numbers of the South African natives beginning work in the mines⁸ and has been described years ago in epidemics among sailors long deprived of fresh fruits and vegetables It has been reproduced in man under controlled conditions⁹ This later study revealed that an ascorbic acid level of zero in the plasma appeared after 41 days and in the white cell platelet layer after 87 days of complete depletion No symptoms other than loss of weight appeared for 4 months This is corroborated by observations in this clinic that some individuals may have no ascorbic acid in their plasma and yet show no effects of this After about 132 days of complete depletion there appeared a papular skin eruption and only after about 161 days did the first classical sign of perifollicular hæmorrhage develop An experimental wound now showed delayed healing due to failure to form intercellular substance, while after 3 months of complete depletion wound healing was normal Capillary fragility tests were normal No other signs appeared in this controlled depletion experiment Low ascorbic acid has been found in a few cases of gingivitis at the dental clinic, one or two with irritations from dentures These have responded to ascorbic acid therapy

Vitamin D deficiency produces symptoms during the growth period and these are related to imperfect and delayed bone formation manifested in the clinical picture of rickets Again no otolaryngological signs are common to this deficiency state No other known clinical vitamin deficiency states are known although the tocopherols of vitamin E appear to be concerned with the reproductive and nervous function in animals and vitamin K is important in the formation of prothrombin The latter information has been used clinically in controlling surgical bleeding of patients with obstructive jaundice and is useful in hæmorrhagic states of the newborn before the bacterial flora of the intestinal tract becomes established With the aid of bile salts, bacteria in the intestine can apparently mobilize this vitamin

Criteria for defining known deficiency states in man are still in the process of formulation¹⁰ They include quantitative chemical determinations Until these criteria are established the subclinical vitamin

deficiency state cannot be seriously considered. In the otolaryngologic literature a number of articles have appeared in which the author has attempted a correlation between vitamins and the diseased states^{11, 12, 13, 14}. While a great deal of work was done in attempting to evaluate the general status of the patients studied, the evidence for a vitamin deficiency state was not convincing and the multiplicity of therapeutic procedures with numerous vitamins and endocrines often made it impossible to analyse the results. Furthermore the results reported were not conclusive, but rather could be considered to be within the limits of experimental error as for repeated audiograms or could be explained on the basis chosen for therapy—cases in which variations in symptoms could reasonably be expected—such as patients with tinnitus, allergy or Ménière's disease. Generally there appears to be very little basic information in the clinical vitamin studies reported thus far by otolaryngologists. This is no reflection on the clinician's work except that the evidence presented in this work did not warrant their conclusion of a definite relationship existing in their human material between various clinical pathologic states and the vitamins.

In contrast to many necessarily poorly controlled clinical studies the controlled animal experiment and biochemical studies continue to bring new light on the physiology of the vitamins and suggests possible ultimate application to otolaryngology. However, extreme caution should be exercised in transposing the results of vitamin experiments on animals to the clinic. The following personal observations exemplify this:

From the otologist's standpoint perhaps one of the most suggestive experiments is that of Mellanby on Vitamin A depletion of dogs.¹⁵ I studied this problem in the rabbit and confirmed his observations that you can produce marked hyperplasia of the bone at the internal meatus.¹⁶ His preparations showed also extensive degeneration of the spiral ganglion and end organ. That these changes were secondary to pressure effects of the bone narrowing the internal acoustic meatus and not a primary neural effect of the vitamin A depletion is shown by the absence of these findings in the depleted rabbits. In our animals with one exception the amount of new bone formation was not sufficient to destroy the VIIIth nerve directly or by interference with the blood supply. Furthermore this was verified by testing the cochlear function before and after depletion using the acoustic middle-ear muscle reflex as an index of cochlear function. The experiments were carefully controlled and the vitamin A level of the plasma was determined by the antimony trichloride reaction with the aid of a photo-electric colorimeter. The striking pathology of the temporal bones of these vitamin A depleted rabbits as well as those of Mellanby's dogs would at first glance suggest a really important translation value to clinical otology. However, a careful analysis of all the factors concerned does not bear this out. First of all this experimentally

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produced temporal bone pathology practically has no counterpart in human temporal bone pathology. Of the thousands of human temporal bones that have been studied there exist but one or two descriptions that resemble this experimental lesion.¹⁷ Furthermore the bony hyperplasia in the experimentally depleted animal is not confined to the internal auditory meatus but rather generally involves the posterior fossa surface as well as the spinal canal. While Mellanby previously thought that the multiple peripheral spinal nerve degeneration he found in his depleted animals was a primary effect, he has now found the explanation in the bony hyperplasia about the spinal nerve foramina.¹⁸ Similar experiments carried out on adult animals are entirely negative probably because the reserve of vitamin A stored in the liver is practically impossible of exhaustion. Only growing young animals will show changes. Further, these animals even on complete depletion have to be carried for a long period relative to their life span before signs of depletion develop. By this time they are markedly retarded in growth, have xerophthalmia and are generally in such a poor state of health that death may soon intervene. Another point is brought out in considering the results of our experiments. Other workers reporting on changes in vitamin A depleted rats noted a high incidence of middle ear infections.^{19, 20} Our animals did not show this. This again illustrates the danger of transposing results from one experimental animal to another and particularly from the experimental animal to man. Referring again to clinical or pathological studies of vitamin A depletion in man we find no mention of this temporal bone or cranial base pathology or evidence of deafness. Lastly we are confronted with the fact that vitamin A deficiency as manifested by its classical signs in man is practically unknown in this country. The adequate vitamin A intake of most of our population plus the fact that liver stores seem adequate through very long periods of depletion explain this. The biophotometer tests for dark adaptation are not considered reliable enough to be proof by themselves of a definite vitamin A deficiency state or at best suggest the extremely mild deficiency state. Reviewing our experimental material in this light, we see that otologic problems in the clinic are not likely to be explained on the basis of vitamin A deficiency. Many of the experimental observations of vitamin depletion in animals have been reviewed from an otolaryngological angle²¹ but they should be examined critically along the lines indicated by the analysis of the results of this vitamin A depletion study when considering their clinical application.

The physiology of overdoses of vitamins is still very obscure and as yet offers little prospect of special value to the otolaryngologist. Usually the amount of vitamin in excess of the body need is eliminated. The use of vitamins for a transitory pharmacologic effect—as for example producing vasodilation with nicotinic acid, may be mentioned only to point

out another doubtful method of use. One cannot expect to relieve a long standing pathological process by inducing a pharmacologic effect lasting only a few hours. Only changes in transient symptoms may be expected by such treatments.

While a critical analysis of our present knowledge of the vitamins gives us little of proven value as regards the clinical problems encountered by the otolaryngologist, one cannot underestimate the contribution of the laboratory worker, biochemist and clinician in increasing our knowledge of basic biologic phenomena of cellular physiology as related to nutrition. Continued growth of our knowledge in this field, together with carefully controlled studies in man give promise that answers to some of the unsolved problems in otolaryngology may be forthcoming.

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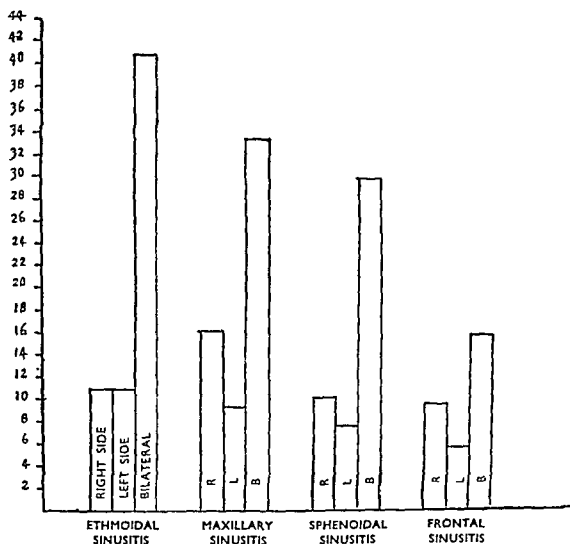
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SINUS DISEASES AND NATURAL DEFENCES

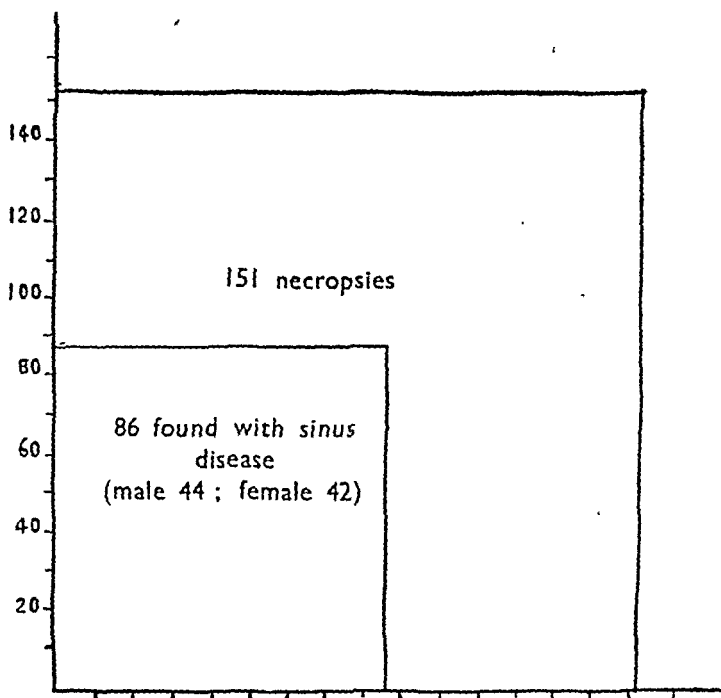
By J. G. WHITAKER (Sao Paulo)

As the mucous membrane which lines the accessory nasal cavities is in direct continuation with that of the nasal cavity, it is not to be wondered at that severe colds turn into sinus troubles at least once in a lifetime. The headaches which frequently accompany influenza are, in many of the cases, due to sinus infections.

The frequency of sinusitis is reaffirmed by post-mortem examinations. In 151 corpses examined in this city, 86, or 56.91 per cent., had sinus trouble (44 men and 42 women). The ethmoid was found to be affected in 63 cases, the maxillary in 58, the sphenoid in 46 and the frontal in 29. These facts are more clearly shown in Graph I and are also verified in daily practice.



GRAPH 1.—Frequency according to regions



GRAPH 2.—Frequency in sinusitis.

Records were also made as to the accompanying disease, and the results obtained were as follows: Of the 55 cases of cardio-vascular diseases 33 also had sinusitis; 38 cases of tuberculosis showed 22 with infection of the nasal cavities, and in 15 cases of pneumonia 11 were positive as to the sinuses. Of the 38 cases of different diseases, such as typhoid, diabetes, cachexia, secondary anæmia, cirrhosis, Laënnec's atrophy, visceral polyesteatosis, dysentery and pulmonary abscesses, one case of sinusitis was found for each: two positive cases were discovered in each of the following: emphysema, gastric and duodenal ulcers, carcinoma and two undetermined illnesses.

Dacryocystitis: 131 of the bodies were also subjected to West's operation on both sides. In 20 of these cases the lachrymal sacs were found to be affected, and out of these 5 showed no nasal infection. In 6 cases the dacryocystitis was bilateral, out of which one showed no sinusitis. Maxillary sinus trouble was found to accompany dacryocystitis most frequently.

These figures, obtained by us, were found, when compared to those of other authors, to be higher and to show a greater percentage of infection than has hitherto been observed. The following statistics were collected by A. Denker (Vol. II, "Handbuch der Hals-Nasen-Ohrenheilkunde", Denker-Kahler).

Sinus Diseases and Natural Defences

Cases of sinusitis found by :

Harke	138 in 395	34·937%
Fränkel	63 in 146	43·151%
Gadowige	45 in 203	22·167%
Lafalle	78 in 169	46·154%
Martin	15 in 31	48·387%
Wertheim	165 in 306	53·922%
Mindeo	14 in 50	28·000%
Oppikofer	94 in 200	47·000%
Schonemann	31 in 83	37·349%
Kirklan	35 in 100	35·000%
J. G. Whitaker ..	86 in 151	56·954%

When considering only maxillary sinusitis we have :

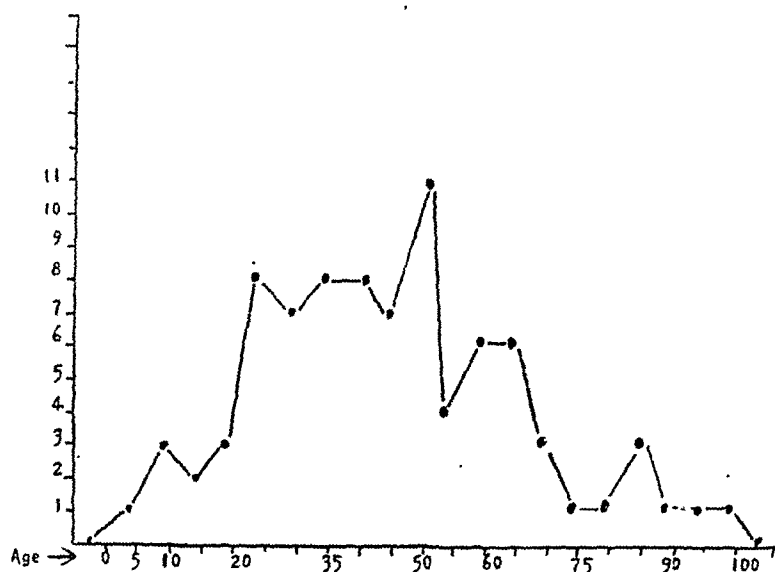
Inschokosky	12 in 152	7·895%
J. G. Whitaker	58 in 151	38·411%

When studying the statistics obtained by Denker we noted that the cases present in bodies examined after violent deaths were relatively less than in other fatal causes. Our experience in this line was different ; thus, out of 73 cases of violent deaths, examined by us in the mortuary when the bodies were no more than six hours old, 43 were found to show *signs of sinusitis*. Out of 28 suicides 20 were positive sinusitis cases, and 8 corpses out of 15 cases of homicides showed sinus infection.

The most prevalent type of sinusitis observed amongst these 73 cases was again found to be ethmoidal, 38 cases, 19 were maxillary, 13 sphenoidal and 7 frontal.

These statistics are incomplete as endonasal operations could not be performed on small children without the mutilation of their faces, which did not seem justifiable. In practice, however, the number of sinus cases amongst children is probably as frequent as that in adults. Nasopharyngitis, which is so well known amongst pediatricians, is nearly always due to infection of the posterior accessory nasal cavities (sphenoidal sinusitis and ethmoidal cells in different stages of development which can also be present in an early stage). These cavities drain their pathological secretions to the back of the nose and to the stomach. We have treated a case of acute ethmoidal sinusitis in a 40 day-old baby. This case was accompanied by slight manifestations in and inflammation of the middle ear cavity.

Graph III is interesting as it shows the relation between the frequency of sinus diseases and the age of the patients. Thus we see that the prevalence of these troubles is greater between the ages of 20 and 40.



GRAPH 3.—Frequency according to age.

Observations were also made on patients in one of our fever hospitals, where we surmised these diseases would heighten the frequency of sinus troubles. Such was not the case as the following figures clearly show, thus, in 135 cases of diphtheria, all with positive cultures, we diagnosed sinusitis in only 16 cases; all of these were cured exclusively with specific serums without any local treatment. In 121 confirmed cases of typhoid we found 9 with sinus infection. In 14 of these patients *Locus Kieselbachi* was found, with dilated veins; the epistaxis in some cases showed itself shortly before the examination and in others some hours afterwards. Epistaxis was observed in only one other disease, pneumonia. Out of 11 cases of scarlet fever, a disease which is feared by Europeans due to its nasal and auditory complications, only 2 had simple rhinitis. Four cases of infantile paralysis were examined and in 1 case we found rhinitis, while another had nasal pharyngitis. Only one case of rhinitis was found out of the 4 dysentery patients examined. No abnormal nasal signs were found in the 3 tuberculosis and the 2 tubercular meningitis cases. In 7 pneumonia cases only 1 had rhinitis; 2 had pharyngitis, and 2 varicose *Locus Kieselbachi*. One case of septicæmia showed nothing in the nose.

The diseases with which we found sinusitis most frequently associated were cardio-vascular diseases, tuberculosis and pneumonia. These two are considered allergic diseases and, according to Bordet, allergy is a pathological state in which capillaries play a capital rôle.

It was this that attracted our attention to the relation between "chronic sinusitis—capillary disturbance".

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According to Bordet phagocytosis is the condition *sine qua non* of all natural defences*. Experiments show that the local natural defences can be rendered more efficient, viz the injection of cultural broth into the peritoneal cavity draws a considerable amount of leucocytes almost immediately. We were induced to try the same experiment in the paranasal cavities, which though internal are connected to the exterior by means of their ostia. We verified that the flow was even more rapid than in the peritoneum, indeed it was almost instantaneous.

Certain substances prove favourable to an influx of phagocytes, in this respect potassium iodide is excellent for provoking phagocytosis, especially of the macrophages. The behaviour of potassium iodide in these cases has not yet been fully explained. Cantacuzene observed that when he injected 0.10 grs of this substance daily into a guinea-pig, 0.10 grs of tubercular bacilli, injected beneath the skin, was rapidly absorbed in 5 or 6 days. There is no doubt that the efficiency of potassium iodide in syphilitic gummas and actinomycotic tumours is due to the stimulation of phagocytosis. It also excites the lymphoid tissue of the glands and the spleen tissue and induces hypernucleosis (Bordet pp 224-44). Hamburger (cited by O. Muller) reaffirms that KI increases the permeability of the capillary walls.

In acute sinus troubles, phagocytosis is seen to exist by the purulent nasal, or naso-pharyngeal secretion, thus, it is only necessary to take advantage of this circumstance. From Hunter and Metchnikoff we know of the use of inflammation as a means of defence against infection. However, if the inflammation is excessive it should be controlled, but when insufficient it should be stimulated. As doses of certain medicines vary not only with each individual but according to the case and circumstances, so also the optimum of hyperæmia advantageous for defence depends on each separate case. The art of medicine lies in bringing the hyperæmia within this optimum limit.

The use of cocaine is very adequate for regulating the intensity of the acute nasal inflammation. In 1910 Ninian Bruce showed that when mustard oil was applied to the ocular conjunctiva the resulting hyperæmia depended on the local sensitive innervation of the mucous membrane. If the nerves which went to that region were severed at some distance the redness would be in evidence but, if the peripheral nerves in the ocular conjunctiva were numbed or were in degeneration this reaction was not observed. The anatomical substrata of this so-called axonic reflex has not yet been found in spite of the great number of researches in this matter. Ten years after Bruce's discovery Breslau found that when the skin is anæsthetized by an intra-dermal injection of novocaine and lightly traumatized, it does not react as usual with hyperæmia. However, the absence of wale on the flesh is only obtained when the injection

* J. Bordet. *Traité d'Immunité dans les Maladies Infectieuses*

is intra-dermal as when it is sub-cutaneous hyperæmia always appears. From this we may conclude that the axonic reflex passes by the fibres in the corium, immediately above or below these, and that, with the pain, the inflammation spreads through the peripheral sensory nerves. (O. Müller, Vol. I, p. 389.) All this is in complete agreement with what has been observed with novocaine or cocaine when applied to a frog's tongue.

In our practice we have often observed how an acute coryza, which may be regarded as a result of hyperæmia of the nasal mucous membrane reacting to a microbe stimulant, is greatly influenced by one or two drops of cocaine chloride solution (20 per cent.) in the nose. Not only do the specific cold symptoms disappear instantaneously but also in some cases these definitely do not reappear. The frequent feeling of interrupting a vicious circle when applying cocaine in these cases becomes more than mere hearsay, as proved by the experiments of Bruce and Breslauer.

When objecting to cocaine on the strength of its paralysing effects on the cilia of the mucous membrane it should be remembered that sinus pus has a more devastating effect, as it paralyses these cilia, which however are restored after the infection passes. The function of these cilia is purely mechanical, they have a still slighter influence in natural defence than the mucous secretion of the nose (Bordet).

J. Bordet and O. Müller emphasize the importance of the capillaries through which "vital exchanges" take place and white corpuscles rush to the defence of the menaced tissues.

We are now convinced that sinus diseases become chronic when the capillaries of the sinus mucous membrane do not let through the required amount of leucocytes, due to a change in their permeability. The alteration in permeability may interfere with the factors of general immunity being centred on the diseased part, this statement being preferable to the so-called true local immunity. In other words, sinusitis becomes chronic when phagocytosis, the most efficient defence process in the organism, does not take place, or is insufficient. The proof of this statement may be found in the rapid cures effected when obstacles impeding phagocytosis are removed.

With these facts in mind we submitted patients to blister treatment, according to O. Müller. At our request the branch office of Johnson & Johnson in this town manufactured adhesive tape containing 7 centigrammes of ground cantharidine spread over an area of 1 square centimetre. This tape was placed preferably on the thigh. In our winter of 1941 we found that the time for blister formation on a normal person between the ages of 12 and 30 was 4 to 5 hours. This time corresponds to the period necessary for blister formation in Europe during summer. Later we found that the same time was required during our summer, while in European winter it takes from 10 to 12 hours.

Of the 24 chronic sinusitis patients submitted to this experiment it

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was found in all cases that the formation of the blisters was retarded from 1 to 10 hours thus inferring a diminution of permeability of the capillary walls in all the cases examined. Those patients who showed a small increase benefited more from subsequent treatment, however, some of those with a greater increase were also cured relatively quickly.

We thus concluded that in chronic sinus diseases phagocytosis must be stimulated by introducing into the sinuses substances capable of provoking the afflux of leucocytes. Pure broth, potassium iodide (10-20 per cent solution), sodium nucleate (10 per cent solution), nitrate of silver (3 per cent solution), are all used for the purpose of stimulating phagocytosis. We prefer potassium iodide as, above all, it produced an afflux of the macrophages. At first the solution should be from 8-10 per cent, because of the pain it provokes when more concentrated, but as the cure progresses, this decreases proportionately. Sodium nucleate, obtained from beer yeast, is difficult to keep, and silver nitrate produces sharp persistent pains besides easily causing argyria. After introducing the leucocyte attracting substance we apply Bruning's light-bath for the head for about 5-7 minutes, with the idea of helping phagocytosis, not by sweating, but because an increase of temperature to 37°C is favourable to phagocytosis (Bordet).

These remedies are introduced by the displaced air method (Proetz), or its more efficient variation in which auto suction is used. The head is rested on the arm of a sofa and bent back as far as it will go, thus making it possible for the remedies to enter all the sinuses besides those affected. Thus a larger area of the mucous membrane is stimulated, and there is also a low cough. The use of cocaine ephedrine (equal parts of a 3 per cent solution) is indispensable for the required opening of the ostia, but it should not be allowed into the sinus as it would cause vaso constriction of the capillaries.

Another method of introducing these substances into the sinus without punctures or probes is by ionization. The above mentioned remedies are placed on a cotton carrier and connected to the positive pole, and introduced into the middle or inferior meatus, or into the canine fossa, or placed against the anterior sphenoid surface. The negative pole can either be a small metal cylinder which is held in the hand or a suede electrode placed against the cheek or the throat, in such a way that the current travels a minimum distance before reaching the affected part.

The normal control of the capillaries is complex. Krogh suspects the presence of a thyroid hormone which regulates the permeability of the capillaries, this regulation being supervised in conjunction with the sexual hormones. Indeed, in chronic sinusitis we found hypothyroidism to be a common occurrence, although mostly in a light degree, we found also cases associated with insufficiency of the hypophysis.

The influence of sugar and salt on the permeability of the capillaries

was demonstrated by O. Müller, whom we quote next, due to the practical appliance in daily practice; at least where the abuse of sweets and seasoned meat frequently occur: firstly, after an intra-venous glucose injection, the result was: the increase of permeability in the capillary walls allows the intensity diluted albumin of the blood to permeate these walls and occupy the peri-capillary lymph spaces; thus it reaches the interstices of the tissues where the state of the lymphatic vessels does not allow of such quick drainage. The other elements of the blood are rarely found to follow this course under the same circumstances. The first effect caused by the œdema formed, which is rich in albumin, is the separating of the tissue-cells. This means that they are further from their nutritive base, a fact which causes the difference in osmotic and electric pressures to become smaller than those normally existing in circulating blood and liquids in the interstitial spaces. This leads to an unfavourable assimilation and disintegration in a greater or a lesser degree. The undrained territory (of a paste-like consistency in children with exudative diathesis) becomes especially sensitive and is easy prey to inflammations. Some people show a congenital predisposition to greater permeability of the capillaries, as in exudative diathesis, and in these cases these features are naturally more intense.

From a purely clinical point of view an excessive meat diet produces different symptoms from those observed after the abuse of sugar in the diet. O. Müller found that the platelets of the blood were reduced to half their normal number after an excessive meat diet. Bordet considers these platelets as having a defensive action in the agglutination of the less virulent bacteria found in circulating blood. Indeed, in several patients submitted to a pre-operative treatment, an increase of platelets has coincided with considerable subjective improvements in cases of chronic inflammation of the tonsils. (J. G. Whitaker, in "Vitaminas e O.R.L. e Hemorragias post-tonsilectomia," *Revista Brasileira de O.R.L.*, Janeiro-Fevereiro-Março-Abril, 1941). This should explain the frequency of catarrhal complaints common in persons whose main diet consists of meat and salt. Besides this, in these cases, there is a passing of red corpuscles through the capillary walls, a fact which explains the symptoms of scurvy and easy bleeding of the gums when the teeth are being brushed, as well as the highly coloured cheeks and the vivid red colouring of the mucous membrane of the nasal septum. In the case of a sugar diet we do not find hyperæmia of the mucous membrane, but, however, the catarrhal complaints are harder to cure.

Among us the abuse of sugar being more frequent causes many more prevalent catarrhal relapses in the upper air passages than those caused by excessive meat diets. In England the frequency of catarrhal inflammation has already been observed amongst the children who eat too many sweets or too much sugar. This was pointed out more than twenty years

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ago when, during the first great war beet-sugar, which came from the Continent, was rationed. During this period there was a definite decrease of catarrhal inflammation amongst the schoolchildren. These symptoms returned after the war and increased in proportion to the consumption of sugar. These observations were made by Paton* who, rightly in our opinion, extends his theory of the unfavourable effect of sugar on the mucous membrane to all other carbohydrates. However, he did not link up these facts with the alterations in the function of the capillaries. In spite of the thick enlarged capillaries found in diabetes, there is, as we have seen, an increase in the blister-formation time and a decrease in permeability. One of our patients, who always ate sweets for dessert and had always sugared all his drinking water since childhood, showed a ten-hours increase in the blister-formation time. Thus, the abuse of sugar, after a time interferes with the permeability of the capillary walls, first augmenting and finally greatly diminishing this factor, as an act of defence against what could become an indefinite infiltration of the tissues. This reacts on the local defence of the tissues, making it difficult or impossible for the phagocytes to pass through the capillary walls. The patient in question showed a definite decrease in the local resistance of the tissues, naso-pharyngeal diseases, which are very frequent in infancy, serious glomerulo-nephritis in later years, phlebitis, serious bacteriemia after recent tonsillectomy, continuous frequent and intense inflammation of both maxillary sinuses, whose mucous membranes had become hypertrophied and were awaiting an opportune moment for surgical treatment.

In treating chronic sinusitis these items, along with any factors which decrease phagocytosis and its consequent diminution of natural resistance should be taken into consideration. Cold is such a factor when it comes in contact with parts of the body which are usually protected. It may well be that the English language uses the same word to denote the weather as much as the reaction of the nasal passages to this weather.

Streptococci may remain in a latent stage inside the phagocytes until later released by traumatism thus causing re-infection (Bordet). Frequently patients are heard to say that any shaking such as that experienced while riding on horseback, or in a car over bumpy roads going downstairs, abrupt exercises, or even the sun's rays provoke the reappearance of forgotten sinus troubles.

When dust is inhaled, these particles are taken up by the phagocytes and thus they take away from the power which should be used against the microbes, weakening resistance.

When the general state of health is bad or after privation, there is a decrease in phagocytosis. This is also confirmed in practice in those who

* J. H. Paton "Relation of excessive carbohydrate ingestion to catarrhs and other diseases", *British Journal* April 29th 1933

J. G. Whitaker

follow a slimming diet and those who easily fall victims to repeated anginas and rhinitis.

Immunity stimulated by phagocytosis is merely local, temporary and not specific. This latter quality, however, is of great advantage due to the multiplicity of etiological sinusitis agents.

Ethmoid sinus troubles are the ones which react most favourably to this treatment of stimulated phagocytosis, specially in the sub-acute stage. It should be noted here that colds are generally ethmoidal infections. Maxillary sinus troubles are the ones which we found most resistant to this treatment, this fact seeming to prove that the North American authors are right in attributing these to dental influence, even if the teeth are found to be normal when X-rayed. In the case of the maxillary sinus, therefore, special care should be taken that the KI solution should reach the floor of the sinus, by letting the patient rise slowly while sucking through the nose, until a sharp pain is felt in the teeth.

With this treatment both subjective and objective symptoms rapidly disappear, lightning cures not being rare in sub-acute cases.

When after the third treatment, every other day, little or poor improvement is noted, we reinforce the action of the potassium iodide by the use of histamine, a potent capillary dilator. (O. Müller.) The instillation of histamine should precede that of KI by one or two minutes. Suction (after Watson-Williams) is also advantageous, its action being twofold: that of removing pus, and of dilating the capillaries.

On other occasions ionization produces a better result. A 30 per cent. solution of the same potassium iodide is used for the purpose, although for maxillary cases we prefer nitrate of silver (4 per cent.) applied with the positive electrode into the mucous membrane of the canine fossa, this fossa being better for the application of nitrate of silver than the inferior meatus.

An average of eight treatments on alternate days shows improvement approaching cure. When this rapidity, shown by all biological defence processes is not observed, the cause is probably due to irreversible changes in the capillary walls, making surgical treatment necessary.

For cases of chronic sinus troubles, we introduced Durante's solution into the cavities which had previously been drained of pus after exposure to X-rays. This method was evolved from that followed by F. Finocchiaro for osteomyelitis. As the Durante solution caused much pain when in contact with the mucous membrane we substituted for it Cholangol (5 per cent. solution). Furthermore, experience soon taught us that acute sinusitis should not be treated by this method.

It became apparent that the action of iodine or colloidal silver on the sinus did not reinforce the possible bactericidal action of the X-rays as Finocchiaro believed. However, the biological effects of the X-rays were increased. O. Müller showed that the erythema dose causes an increase

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in the number of capillaries in the zone receiving X-rays, that is to say, the reserve capillaries (so called by Krogh because they react in times of extra work or infection) dilate, and come into action. In other words, X rays react provoking phenomena similar to those seen in inflammation, including the probable formation of histamine which induces vaso dilatation and greater permeability.

Because of its effects on the capillaries, radiotherapy stimulates phagocytosis, specially when used in conjunction with iodine or silver solutions which attract leucocytes. The results obtained from the X-rays treatment of the sinus are the same, as to the effect on the mucous membrane as those described in this article, that is, it offers local and temporary immunity and no guarantee against near or distant relapses. This being so, the disadvantages of the X-ray therapy are clear because reactions take place in the nerve centres situated near the para-nasal cavities. These we registered in the form of giddiness and sickness, evident in many patients after X-ray treatment of the head. Finally, its price, due to the expensive apparatus necessary makes it impracticable for a nose and throat specialist. It was, however, a useful stage in our work as an incentive in the investigation of natural defence processes in the nose.

We used a Bombix (Siemens) apparatus because of its adaptability to any position, and also because of its slight intensity allowing deep radiations. The filter was of copper and measured 0.5 mm in diameter and we used a varying field.

The hopes that were raised with regard to the so called sulfa compounds because of their $\text{H}_2\text{N} - \text{C}_6\text{H}_4 - \text{SO}_2 - \text{NH}$ -root were not found to be justifiable as remedies for chronic sinusitis. Pyridines were found to raise the opsonic index. Another sulfa group seemed to owe its power to the destruction of the outer membrane of bacteria and their toxin*. These effects tend to facilitate phagocytosis. In 1938 we applied Prontosil and Soluseptazine into the nose by the displaced air method in chronic sinusitis cases with poor results and with three cases of intoxication.

In April of 1941 Turnbull† published heartening results of cases of chronic sinusitis treated with sodium sulfathiazole (normal 5 per cent solution). Of the 47 patients so treated 40 showed subjective improvements (disappearance of the feeling of weight in the head, without return between one week and five months). The initial increase of nasal secretion was not accompanied by obstruction or sneezing, a fact which led Turnbull to believe that this substance did not react by stimulating the mucous membrane.

* Quintino Mingoa in Arquivos de Biologia Junho 1941

† Frederick Mills Turnbull Los Angeles. Intra nasal therapy with sodium salt of sulfathiazole in chronic sinusitis. *The Journal of A M A* April 1941

We submitted 14 chronic sinusitis patients to this treatment for the purpose of verifying Turnbull's results. Instead of the spray used by this author we applied the displaced air method. Our results were negative ; in most cases subjective improvements were seen, but no positive cure was obtained because all the patients, who were carefully watched, continued to have the naso-pharyngeal discharge.

Accidents in sulfatherapy are common. *The Journal of Urology*, March, 1942, relates two cases of kidney calculoses, and one fatal case of uræmia following sulfa treatment.

Vaccine therapy is not successful in chronic sinusitis because it requires an effort which the body has already not been able to make. (Bordet.)

In infections of the posterior accessory nasal cavities (ethmoidal cells and sphenoidal sinus) there is a clinical sign which because of its regularity and frequency is of great semiotic value, greater even than X-rays, which however have the advantage of localization. The secretion formed in those para-nasal cavities flows into the naso-pharynx and adheres to its walls due to its thickness and to its small quantity. From time to time, but especially in the morning or while smoking, or at meal times, due to the masticatory movements or the warmth of the food, it is necessary to expel these accumulated secretions by sniffing deeply through the nose. This sniffing is only possible when the mouth is shut, and the face assumes a characteristic expression which, together with the disagreeable sounds produced, are taken to be signs of bad manners. This sniffing is sometimes said to be due to smoking, but it only occurs in inflammatory diseases of the posterior nasal cavities, thus becoming an important symptom. When the inflammation subsides the need for clearance of the naso-pharynx disappears without this act becoming a habit, even when it has been of long duration.

The following are the most frequent subjective symptoms observed in sub-acute ethmoidal cases : an obstruction at the bridge of the nose and the corners of the eyes, which patients localize by grasping that part of the nose with their forefinger and thumb ; a weight at the temples ; a heavy head and clogged ears ; a stinging or burning in the eyes which causes the patient to complain of the sensation of sand in the eyes.

The diseases of the posterior nasal cavities are the most frequent causes of nasal obstruction, and when correctly diagnosed, an appreciable number of operations on the nasal septum could be avoided. They are also the cause of the continual return of suppuration and catarrh in the ear and even in children these cavities should be checked on before blaming adenoids.

Of all sinus troubles the diseases of the ethmoid bone are those which most frequently produce focal infection, this because the ethmoid bone is divided into independent cells, one of the necessary factors in the

Sinus Diseases and Natural Defences

formation of a focus of infection*—namely, (a) inflamed tissue should be isolated from the exterior (b) the surrounding area should be poorly supplied with blood vessels so that the forming infectious centre be protected from the purifying effect of circulating blood, (c) this isolation however, should not be complete, thus allowing the body to react to the passing through of small quantities of toxins or bacteria by producing an immunity which is never complete, thus permitting relapse or reinfection.

According to Vogel sinusitis cases with focal symptoms are of secondary importance when compared to the focuses formed in the teeth (granulomas and specially empty roots) in the first place and the tonsils in the second. This is because the sinuses do not fulfil the anatomical conditions, with the exception of the ethmoid cells, required for the formation of focal infection.

Still quoting from Vogel we give the most frequent subjective symptoms accompanying focal infection. Fibrillar contraction of the muscles of the face (eyelids), palpitations which are most frequent when resting in bed, a tired feeling on rising in the morning, nervousness and irritability, mental fatigue and slight temperatures.

It is curious to find that contractions of the muscular fibrillae, irritability, mental fatigue, tiredness on rising are also symptoms of lack of vitamin B †.

With these subjective symptoms and rhinoscopic examinations the diagnosis of chronic post-nasal infection is easy and its localization alone is left to X-rays. Even so, the plates should be interpreted by a nose and throat specialist who would not rely solely on the radiologist's report. In the numerous X rays taken of bodies resulting from violent or sudden recent death, we found that the slight infections specially catarrhs which are so commonly encountered in daily practice, were but briefly registered on the plates. This fact led two well known radiologists to whom the plates were submitted for inspection to confirm the normal appearance of the sinuses. However, for purposes of control we operated immediately after and found from mere inspection of the mucous membrane that this was altered, and later we confirmed our diagnosis with histopathological examinations. Bodies more than six hours old even when kept in ice chests, have different radiological images due to the post mortal alterations of their tissues. Rhese's position seemed to us to be the best for X rays of the ethmoid cells and sphenoid sinuses.

Summary

Because certain substances such as potassium iodide and pure broth cause a flow of leucocytes when in contact with the peritoneal membrane thus increasing local defence, we were induced to try the same experiment

* Klaus Vogel Die Herdinfection in Gebiet des Hals Nasen Ohrenarztes 1940

† J G Whitaker Vitamins em O R L Revista Brasileira de O R A April 1941

in the para-nasal cavities for chronic sinusitis treatment. We found that the mucous membrane in the sinuses was every bit as sensitive to these substances, as the influx of leucocytes was immediate.

This leucocyte stimulation is only necessary in chronic sinusitis, because in acute cases phagocytosis already exists as is proved by the purulent nasal secretion, and needs only to be made use of.

Chronic cases are caused not so much from insufficient drainage as from disturbance of permeability in the capillary walls, preventing the leucocytes from passing through, thus impairing defence.

Phagocytosis can only be excited when the capillary walls have merely functional lesions and are capable of being completely restored. If these lesions are irreversible, a fact which is shown by lack of progress in the above treatment, surgery is the only adequate treatment.

Considering the danger of intoxication in the sulfa treatment and that of the X-ray treatment to the central nervous system, the method of stimulating phagocytosis, which is perfectly harmless, is also, we believe, the most adequate for sinus treatment, for our statistical results have shown this clearly.

There is no definite immunity against sinusitis. Our duty as specialists is to show patients how to prevent this disease by paying attention to their glands, their diet and the external factors which may influence the capillary system: continual wetting of the hair, cold baths of excessive duration, too many hot baths, too much strongly-seasoned meat without an adequate quantity of vegetables and fruit, and too many sweets are all habits which should be modified in the prevention of sinus diseases.

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These statistics include old people and children.

79 individuals between the ages of 20 and 49 (adults)	{ sinusitis 49 nil 30	{ white 24 coloured 25
53 individuals between the ages of 50 and 100 (old people)	{ sinusitis 26 nil 27	{ white 18 coloured 8
19 individuals between the ages of 2 and 19 (children)	{ sinusitis 11 nil 8	{ white 4 coloured 7
151 bodies	{ 86 sinusitis 65 nil	{ white 46 coloured 40

Sinus Diseases and Natural Defences

The following figures show the relation between sinusitis and the diseases accompanying it

Cardio vascular diseases 55	{ sinusitis 33 nil 22	{ white 18 coloured 15
Tuberculosis 38	{ sinusitis 22 nil 16	{ white 11 coloured 11
Pneumonia 15	{ sinusitis 11 nil 4	{ white 3 coloured 8
Different diseases	{ sinusitis 18 nil 20	{ white 12 coloured 6

Bodies examined 151

Positive sinusitis cases 86 in 151 56 954% Men 44 in 86 51 163%
Women 42 in 86 48 837%

<i>Ethmoidal sinusitis</i>	right side	11 cases in 86	12 791%
	left side	11 cases in 86	12 791%
	bilateral	41 cases in 86	47 674%
Total number of Ethmoidal sinusitis cases		63 cases in 86	73 256%

Of these 63 Ethmoidal sinusitis cases there were

Ethmoidal sinusitis	right side	11 cases in 63	17 460%
	left side	11 cases in 63	17 460%
	bilateral	41 cases in 63	65 080%

<i>Maxillary sinusitis</i>	right side	16 cases in 86	18 605%
	left side	9 cases in 86	10 465%
	bilateral	33 cases in 86	38 372%
Total number of Maxillary sinusitis cases		58 cases in 86	67 442%

Of these 58 cases there were

Maxillary sinusitis	right side	16 cases in 58	27 586%
	left side	9 cases in 58	15 517%
	bilateral	33 cases in 58	56 897%

<i>Sphenoidal sinusitis</i>	right side	10 cases in 86	11 628%
	left side	7 cases in 86	8 139%
	bilateral	29 cases in 86	33 721%
Total number of Sphenoidal sinusitis cases		46 cases in 86	53 488%

Of these 46 cases there were

Sphenoidal sinusitis	right side	10 cases in 46	21 739%
	left side	7 cases in 46	15 218%
	bilateral	29 cases in 46	63 043%

<i>Frontal sinusitis</i>	right side	9 cases in 86	10 465%
	left side	5 cases in 86	5 814%
	bilateral	15 cases in 86	17 442%
Total number of Frontal sinusitis cases		29 cases in 86	33 721%

Of these 29 cases there were

Frontal sinusitis	right side	9 cases in 29	31 035%
	left side	5 cases in 29	17 241%
	bilateral	15 cases in 29	51 724%

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Number of bodies examined 151

Diseases revealed in the respective post-mortems :

<i>Cardio-vascular diseases</i> :	with sinusitis	white	..	..	18 in 151	11.921%
		coloured	..	..	15 in 151	9.933%
Total	with sinusitis	..	..	..	33 in 151	21.854%
	without sinusitis	..	..	..	22 in 151	14.570%
Total number of bodies with cardio-vascular diseases					55 in 151	36.424%

Of the 55 bodies with cardio-vascular diseases :

with sinusitis	..	..	..	33 in 55	60.000%
without sinusitis	..	..	..	22 in 55	40.000%

<i>Tuberculosis</i> , with sinusitis :	white	..	..	..	11 in 151	7.285%
	coloured	..	..	..	11 in 151	7.285%
Total	with sinusitis	..	..	..	22 in 151	14.570%
	without sinusitis	..	..	..	16 in 151	10.596%
Total number of bodies with tuberculosis					38 in 151	25.166%

Of the 38 bodies with tuberculosis :

with sinusitis	..	..	..	22 in 38	57.895%
without sinusitis	..	..	..	16 in 38	42.105%

<i>Pneumonia</i> with sinusitis :	white	..	..	..	3 in 151	1.987%
	coloured	..	..	..	8 in 151	5.298%
Total	with sinusitis	..	..	..	11 in 151	7.285%
	without sinusitis	..	..	..	4 in 151	2.694%
Total number of bodies with pneumonia :						
	with sinusitis	..	..	..	11 in 15	73.333%
	without sinusitis	..	..	..	4 in 15	26.667%

<i>Cardio-vascular pneumonia</i> :	with sinusitis :	white	..	..	1 in 151	0.663%
		coloured	..	..	1 in 151	0.663%
Total	with sinusitis	..	..	..	2 in 151	1.326%
	without sinusitis	..	..	..	3 in 151	1.986%
Total number of cardio-vascular pneumonia					5 in 151	3.312%

Of these bodies with cardio-vascular pneumonia :

with sinusitis	..	..	..	2 in 5	40.000%
without sinusitis	..	..	..	3 in 5	60.000%

<i>Miscellaneous diseases</i> :	with sinusitis :	white	..	..	12 in 151	7.947%
		coloured	..	..	6 in 151	3.974%
Total	with sinusitis	..	..	..	18 in 151	11.921%
	without sinusitis	..	..	..	20 in 151	13.245%
Total number of bodies with these diseases					38 in 151	25.166%

Of these bodies with miscellaneous diseases :

with sinusitis	..	..	..	18 in 38	47.368%
without sinusitis	..	..	..	20 in 38	52.632%

Number of bodies examined 151

Bodies with sinusitis	..	..	..	white	46 in 151	30.464%
				coloured	40 in 151	26.490%
Total number of bodies with sinusitis	..	..	..		86 in 151	56.954%
Of the 86 bodies with sinusitis :	..	..	..	white	46 in 86	53.488%
				coloured	40 in 86	46.512%
Bodies examined from 2 to 19 years	..	..	..		19 in 151	12.583%
20 to 49 years	..	..	..		79 in 151	52.318%
50 to 100 years	..	..	..		53 in 151	35.099%

Of the bodies from 2 to 19 years; with sinusitis

white	..	4 in 19	21.053%
coloured	..	7 in 19	36.842%
Total number with sinusitis	..	11 in 19	57.895%
Of the 11 with sinusitis	..	4 in 11	36.364%
	..	7 in 11	63.636%

Sinus Diseases and Natural Defences

<i>Of the bodies from 20 to 49 years</i>	with sinusitis	white	24 in 79	30 380%
		coloured	25 in 79	31 645%
Total number with sinusitis			49 in 79	62 025%
Of the 49 with sinusitis		white	24 in 49	48 980%
		coloured	25 in 49	51 020%

<i>Of the bodies from 50 to 100 years</i>	with sinusitis	white	18 in 53	33 063%
		coloured	8 in 53	15 049%
Total number with sinusitis			26 in 53	49 057%
Of the 26 with sinusitis		white	18 in 26	69 230%
		coloured	8 in 26	30 769%

Bodies examined at the Faculty 151

Ethmoidal sinusitis

Right side	11 in 151	7 285%	coincides with the maxillary on the same side in	10 out of 11	90 909%
Left side	11 in 151	7 285%	coincides with the maxillary on the same side in	8 out of 11	72 727%
Bilateral	41 in 151	27 152%	coincides with the maxillary on both sides in	18 out of 41	43 902%
Total number of <i>ethmoidal</i> sinusitis cases	63 in 151	41 722%			

Maxillary sinusitis

Right side	16 in 151	10 596%	coincides with the ethmoid on the same side in	10 out of 16	62 500%
Left side	9 in 151	5 960%	coincides with the ethmoid on the same side in	8 out of 9	88 889%
Bilateral	33 in 151	21 854%	coincides with the ethmoid on both sides in	18 out of 33	54 545%
Total number of <i>maxillary</i> sinusitis cases	58 in 151	38 411%			

Violent deaths 73	{	sinusitis 43	{ white 37 dark skinned 4 black 2
		nil 30	{ white 23 dark skinned 3 black 4

Suicides 28	{	sinusitis 20	{ white 19 dark skinned 1 black 0
		nil 8	{ white 7 dark skinned 1 black 0

Accidents 30	{	sinusitis 15	{ white 10 dark skinned 3 black 2
		nil 15	{ white 14 dark skinned 1 black 0

Homicides 15	{	sinusitis 8	{ white 8 dark skinned 0 black 0
		nil 7	{ white 2 dark skinned 1 black 4

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Bodies examined in the mortuary 112

Violent deaths .	suicides	28	in	112	25.000%
	accidents	..	..	..	..	30	in	112	26.786%
	homicides	..	..	..	..	15	in	112	13.393%
Total number of violent deaths		..	..	..	..	73	in	112	65.179%
Of these 73 cases .	suicides	..	..	..	..	28	in	73	38.356%
	accidents	..	..	..	..	30	in	73	41.906%
	homicides	..	..	..	..	15	in	73	20.548%
Still with reference to these 73 cases		..	..	..	..	60	in	73	82.190%
	white	..	..	..	..	7	in	73	9.590%
	dark skinned	..	..	..	..	6	in	73	8.220%
Violent deaths with sinusitis	..	..	..	..	..	37	in	60	61.667%
	white	..	..	..	..	4	in	7	57.143%
	dark skinned	..	..	..	..	2	in	6	33.333%
Total number of deaths with sinusitis		..	..	..	..	43	in	73	58.904%
Of these 43 cases with sinusitis	..	..	..	..	..	37	in	43	86.047%
	dark skinned	..	..	..	..	4	in	43	9.302%
	black	..	..	..	..	2	in	43	4.651%
Suicides		..	..	..	..	26	in	73	36.616%
	dark skinned	..	..	..	..	2	in	73	2.740%
	black	..	..	..	..	0			
Total number of suicides		..	..	..	..	28	in	73	39.088%
Of these 28 cases	..	..	..	..	..	26	in	28	92.857%
	dark skinned	..	..	..	..	2	in	28	7.143%
Suicides with sinusitis		..	..	..	..	19	in	26	73.077%
	white	..	..	..	..	1	in	2	50.000%
Total number of suicides with sinusitis		..	..	..	..	20	in	28	71.429%
Of these 20 cases	..	..	..	..	..	19	in	20	95.000%
	dark skinned	..	..	..	..	1	in	20	5.000%
Accidents		..	..	..	..	24	in	73	32.876%
	dark skinned	..	..	..	..	4	in	73	5.280%
	black	..	..	..	..	2	in	73	2.740%
Total number of accidents		..	..	..	..	30	in	73	39.736%
Of these 30 cases	..	..	..	..	..	24	in	30	80.000%
	dark skinned	..	..	..	..	4	in	30	13.333%
	black	..	..	..	..	2	in	30	6.667%
Accidents with sinusitis		..	..	..	..	10	in	24	41.667%
	white	..	..	..	..	3	in	4	75.000%
	dark skinned	..	..	..	..	2	in	2	100.000%
Total number of accidents with sinusitis		..	..	..	..	15	in	30	50.000%
Of these 15 cases	..	..	..	..	..	10	in	15	66.667%
	dark skinned	..	..	..	..	3	in	15	20.000%
	black	..	..	..	..	2	in	15	13.333%
Homicides		..	..	..	..	10	in	73	13.699%
	dark skinned	..	..	..	..	10	in	73	1.370%
	black	..	..	..	..	4	in	73	5.479%
Total number of homicides		..	..	..	..	15	in	73	20.548%
Of these 15 cases	..	..	..	..	..	10	in	15	66.667%
	dark skinned	..	..	..	..	1	in	15	6.667%
	black	..	..	..	..	4	in	15	26.667%
Homicides with sinusitis		..	..	..	..	8	in	10	80.000%
	white	..	..	..	..	0	in	1	
	dark skinned	..	..	..	..	0	in	1	
	black	..	..	..	..	0	in	1	
Total number of homicides with sinusitis		..	..	..	..	8	in	15	53.333%
Of these 8 cases	..	..	..	..	..	8	in	8	100.000%

Bodies examined in the mortuary 112

<i>Natural deaths 39</i>									
Natural deaths with sinusitis		..	..	..	..	16	in	39	41.026%
<i>Violent deaths 73</i>									
Violent deaths with sinusitis		..	..	..	..	43	in	73	58.904%

Sinus Diseases and Natural Defences

Of these 112 bodies the following were found to *have* sinusitis

Natural deaths	16
Violent deaths	43
Total	59 cases in 112 52 679%

Of the 73 cases of violent deaths with sinusitis

Of the 75 cases of violent deaths with sinusitis									
Ethmoidal 38	{	right 8		Maxillary 19	{	right 4			
		left 4				left 7			
		bilateral 26				bilateral 8			
Sphenoidal 13	{	right 5		Frontal 7	{	right 0			
		left 2				left 3			
		bilateral 6				bilateral 4			
								{	women 1 (15 yrs)
									men 1 (18 yrs)
	{	Suicides 2	{	sinusitis 2	{	white 2			
				nil 0		dark skinned 0			
						black 0			
Children 7 (2 to 19 yrs)	{	Homicides 0							
	{	Accidents 5	{	sinusitis 5	{	white 3 men			
				nil 0		dark skinned 1 man			
						black 1 man			
									</

Number of bodies in the mortuary 112

Natural deaths 39 in 112 34 821%

Ethmoidal sinusitis

Right side	1 in 39	2 564%	coincides	with the maxillary on the same side
			1 in 1	100 000%
Left side	1 in 39	2 564%	coincides	with the maxillary on the same side
			1 in 1	100 000%
Bilateral	13 in 39	33 333%	coincides	with the maxillary on the same side
			5 in 13	38 462%
Total number of ethmoidal sinusitis cases	15 in 39	38 426%		

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Maxillary sinusitis

Right side	1 in 39	2 564%	coincides with the ethmoid on the same side
			1 in 1 100.000%
Left side	2 in 39	5 128%	coincides with the ethmoid on the same side
			1 in 2 50.000%
Bilateral	7 in 39	17 949%	coincides with the ethmoid on the same side
			5 in 7 71.429%
Total number of maxillary sinusitis cases			
			10 in 39 25 641

Sphenoidal sinusitis

Right side	0		
Left side	2 in 39	5 128%	
Bilateral	7 in 39	17 949%	
Total number of sphenoidal sinusitis cases			
			9 in 39 23.077%

Frontal sinusitis

Right side	0		
Left side	1 in 39	2 564%	
Bilateral	4 in 39	10 256%	
Total number of frontal sinusitis cases			
			5 in 39 12.820%

Violent deaths 73 in 112 65 179%

Ethmoidal sinusitis

Right side	8 in 73	10 949%	coincides with the maxillary on the same side
			1 in 8 12.500%
Left side	4 in 73	5.479%	coincides with the maxillary on the same side
			2 in 4 50.000%
Bilateral	26 in 73	35.616%	coincides with the maxillary on the same side
			5 in 26 19.231%
Total number of ethmoidal sinusitis cases			
			38 in 73 52.054%

Maxillary sinusitis

Right side	4 in 73	5 479%	coincides with the ethmoid on the same side
			1 in 4 25.000%
Left side	7 in 73	9 589%	coincides with the ethmoid on the same side
			2 in 7 28.571%
Bilateral	8 in 73	10 959%	coincides with the ethmoid on the same side
			5 in 8 62.500%
Total number of maxillary sinusitis cases			
			19 in 73 26.027%

Sphenoidal sinusitis

Right side	5 in 73	6 849%	
Left side	2 in 73	2 740%	
Bilateral	6 in 73	8 219%	
Total number of sphenoidal sinusitis cases			
			13 in 73 17.808%

Frontal sinusitis

Right side	0		
Left side	3 in 73	4 110%	
Bilateral	4 in 73	5 479%	
Total number of frontal sinusitis cases			
			7 in 73 9.589%

Of the 112 bodies examined, ethmoidal and maxillary sinusitis occurred on the same side in the following proportions

Ethmoidal sinusitis

Right side	9 in 112	8 036%	coincides with the maxillary on the same side
			2 in 9 22.222%
Left side	5 in 112	4 464%	coincides with the maxillary on the same side
			3 in 5 60.000%
Bilateral	39 in 112	34 821%	coincides with the maxillary on the same side
			10 in 30 25 641%
Total number of ethmoidal sinusitis cases			
			53 in 112 47.321%

Maxillary sinusitis

Right side	5 in 112	4 464%	coincides with the ethmoid on the same side
			2 in 5 40.000%
Left side	9 in 112	8.036%	coincides with the ethmoid on the same side
			3 in 9 33.333%
Bilateral	15 in 112	13.393%	coincides with the ethmoid on the same side
			10 in 15 66.667%
Total number of maxillary sinusitis cases			
			29 in 112 25 893%

Sinus Diseases and Natural Defences

VIOLENT DEATHS 73 in 112 16 65 179%	Children under 7 yrs 7 in 73 9 589%	Suicides 2 in 7 28 571%	sinusitis 2 in 2 100 000%	white { man 1 2 in 2 } woman 1 100 000% dark skinned 0 black 0
		Homicides 0	nil 0	
		Accidents 5 in 7 71 429%	sinusitis 5 in 5 100 000%	white 3 in 5 60 000 (3 men) dark skinned 1 in 5 20 000% (1 man) black 1 in 5 20 000% (1 man)
	Adults 20 to 49 yrs 54 in 73 73 973%		nil 0	
		Suicides 18 in 54 33 333%	sinusitis 12 in 18 66 667%	white { men 5 11 in 12 } women 6 91 667% dark skinned 1 in 12 8 333% (1 man) black 0
		Homicides 14 in 54 25 926%	sinusitis 8 in 14 57 143%	white { men 3 8 in 8 } women 5 100 000% dark skinned 0 black 0
		Accidents 22 in 54 40 721%	sinusitis 9 in 22 40 909%	white { men 5 6 in 9 } women 66 667% dark skinned 2 in 9 22 222% (2 men) black 1 in 9 11 111% (1 man)
			nil 0	
		Suicides 8 in 12 66 667%	sinusitis 6 in 8 75 000%	white 6 in 6 100 000% (6 men) dark skinned 0 black 0
		Homicides 1 in 12 8 333%	sinusitis 0 nil 1	white 1 in 1 100 000% (1 man) dark skinned 0 black 0
		Accidents 3 in 12 25 000%	sinusitis 1 in 3 33 333 % nil 2	
	Old people over 50 yrs 12 in 73 16 438%			

CLINICAL RECORDS

CASE OF CAVERNOUS SINUS THROMBOSIS WITH RECOVERY

By JAMES M. WISHART (Blackburn)

ALTHOUGH one case has been reported in this country, another in South Africa and several in America, recovery from a cavernous sinus thrombosis is still sufficiently rare that perhaps a clinical record of another such case is justified.

The patient, R.W., a boy aged 4 years, was admitted to the Blackburn and East Lancashire Royal Infirmary on June 5th, 1943. His history was that pain had commenced 2 days previously in the left ear, within a day or two the ear started to discharge and the next day he complained of pain behind the left ear. Prior to admission to hospital there had been no rigor. This was the first time he had had an otitis media. On admission the temperature was 102.6° F; pulse 120; there was a moderately profuse muco-purulent discharge from the left ear and some swelling and tenderness over the whole of the left mastoid process.

On the evening of June 5th a Schwartze's mastoid operation was performed. There was considerable pus throughout the whole of the mastoid process with a perisinus abscess. The wall of the lateral sinus was of a greyish colour—slightly suspicious, but did not appear to justify opening up the sinus. However, the mastoid wound was left open and the House Surgeon and nurses were warned to be on the look out for a rigor. Unfortunately no swab was taken of the pus in the mastoid process.

That day and next day the boy was flushed and very restless and was given *Nepenthe* mm. 5 without any effect. He was also somewhat drowsy.

On the evening of June 6th the House Surgeon reported that the boy had had a rigor at 7.15 p.m., and also that there had been a very slight rigor at 1.20 p.m. At 9.15 p.m. the wall of the lateral sinus which was now greyish-black and sloughy, was widely exposed up to its junction with the superior-petrous sinus and opened. It was completely thrombosed but eventually the thrombus was removed from the upper end and a free flow of blood obtained, but it was impossible to remove the thrombus from the lower end. The sinus was then packed with gauze and the mastoid wound left open. The internal jugular vein was exposed at the level of the cricoid and divided between two ligatures.

Next morning, June 8th, the temperature had dropped to 99° F. but he was still drowsy and fretful. There was no rigor that day. At night his temperature rose to 102.4. His general condition appeared much worse than one hopes to see the day after operating on a lateral sinus thrombosis. A course of Sulphadiazine was commenced at 10 a.m. that morning, with an initial dose of gram 1½ followed by gram. 1 every 4 hours. That night he was cyanotic and this continued for about 10 days. This was considered to be due to the Sulphonamides. He was also very restless and fretful and perspired freely. By the evening, incontinence of faeces and urine developed. His pulse at times was imperceptible and he appeared to be sinking rapidly. Coramine 8 c.c.

Clinical Records

was given and this improved the pulse. At 6.30 p.m. he had another severe rigor and the left upper eye lid was considerably cedematous.

June 9th—the boy's condition was much the same, still very fretful and perspiring freely. The pulse varied from 128-148 and at times was imperceptible. There were no rigors that day but there was now a slight meningeal cry. The cedema of both eye lids of the left eye was more marked but the right eye lids were not affected. There seemed no doubt that the cavernous sinus had become infected, the infection having spread up the superior or inferior petrosal sinus or both. Sulphadiazine did not appear to be having any effect so it was stopped, and, instead, Sulphanilamide gram 1 every 4 hours was given. He was still incontinent. That night the right eye lids now showed some cedema.

June 10th—there is a frequent involuntary twitch of the muscles of the left side of the face and this persisted for several days. Still perspiring freely. Pulse 112-136. Upper and lower lids of both eyes very cedematous but more marked on the left side than the right. Now some proptosis on both sides appeared. Two severe rigors to day—at 9 p.m. and 9.30 p.m. The left pupil was widely dilated and inactive to light. The prognosis appeared hopeless, but as he was still able to swallow, the Sulphanilamide was continued. Surprisingly he was not incontinent that day.

On June 11th he appeared to be even worse and the incontinence had returned. He had a severe rigor during the morning and by evening he was very drowsy. Pulse 122-138.

June 12th—drowsiness even more marked, but cyanosis appeared a little less. He was semiconscious and quite unable to swallow and consequently 5 c.c. of soluble prontosil was given intramuscularly every 4 hours. Still incontinent. A small bed sore appeared over the spine in the lower dorsal region. This fortunately cleared up in a few days with careful nursing.

Next day, June 13th, for the first time, the downward progress of the illness appeared to have been checked. The ward sister reported him as 'a little bright'. He was much more conscious and could swallow a little fluid but, as we felt it was the intramuscular prontosil which had caused improvement this was continued. He was still incontinent.

June 14th—His condition was still further improved and he swallowed fluids well. Intramuscular injection of soluble prontosil was stopped and Sulphanilamide gram 1 was given every 4 hours by mouth. The pulse remained at 120 all day and he was no longer incontinent. The cedema of the eye lids was appreciably less to day.

The following day he swallowed fluids copiously and had a fairly comfortable day—less fretful and less drowsy. The pulse was steadier and of fair volume.

On June 16th he was able to take a little light diet and was definitely better generally, though still somewhat irritable. The pulse remained around 112 all day. His condition was still further improved next day—June 17th—the cedema of eye lids diminishing and proptosis almost gone. He had a fairly good night was much less irritable and slept fairly well.

It appeared that the boy was going to recover from the cavernous sinus thrombosis and he was in a condition now when we could examine his eyes more

A CASE OF RESUMPTION OF HEARING AFTER TWENTY-FOUR YEARS.

By R. WHITAKER, Major, R.A.M.C., G. G. CROWE, Captain, R.A.M.C.

AN Indian soldier, Sepoy Mohamed Hussain, was sent to one of us on 18.12.43 with a history of recent attacks of pain and swelling about the right ear. He had an injury to that side of the head at the age of four, since when the right ear had been totally deaf.

Three months previously an operation had been performed on his right mastoid region.

On examination the right auricle had obviously been completely detached from the skull at the time of the accident and had re-united below the level of the left ear so that the upper margin of the right ear was half an inch below the upper margin of the left. There was a broad horizontal scar $1\frac{1}{2}$ inches long above the ear, adherent to the deeper tissues. The lobule was bound down to another scar below the ear. The meatus was a blind pit $\frac{1}{4}$ inch deep. There was no pain or pre-auricular swelling present. Paresis of the labial, buccal and orbital branches of the right facial nerve was present. A small scar $1\frac{1}{2}$ inches long showed in the usual position of a mastoid incision behind the ear but the mastoid bone had apparently not been interfered with and the wound had been completely sutured. X-ray showed normal appearances in the temporal bone on each side. Hearing by bone conduction was present. He was seen in consultation with Brigadier Formby, Consultant E.N.T. Surgeon, and it was decided to perform a plastic elevation of the auricle and at the same time explore the mastoid region.

Operation was performed on 23.12.43. The scars holding the lobule of the ear down were excised, and then a rectangular area of skin overlying the eminentia scapha in the posterior auricular region, and extending on both sides of the sulcus, was removed. The incision was then prolonged downwards to explore the mastoid process, and on exploration the bony meatus was found full of infected sebaceous material. On removing this, the tympanic membrane could be seen with a small antero-inferior perforation present. There was no connection between the bony meatus and the cartilage of the ear. When the ear was replaced in a normal position the bony meatus lay opposite the cymba conchae. A new opening in the cartilage was therefore made by excising a circular area of cartilage from the cymba conchae of the ear after undermining the skin over the cartilage and retaining this skin to form the lining of the new meatus, thus obviating the need for an epithelial inlay later. A rubber drainage tube, wrapped in vaseline gauze was then introduced into the bony meatus and passed through the new opening into the auricle to form a complete auditory meatus in the form of a straight wide channel. The posterior auricular incisions were then sutured, but first the scaphoid cartilage was sutured to the temporal fascia to lift the ear up to its proper position. A new lobule was then made by undermining the inferior auricular and facial incisions and the face and inferior auricular wounds were then sutured.

Clinical Records

Two weeks after operation the canal was epithelializing well, the drum perforation was healed although the membrane remained lustreless, and rather immobile, and he could hear conversational voice at 4 feet. Four weeks after operation the canal was completely epithelialized and he could hear conversational voice at 17 feet. He is now evincing considerable interest in his new ear.

This case is presented as a case in which the function of hearing was resumed although the tympanic membrane had been cut off, for 24 years, from contact with the air. His recurring attacks of pain and swelling were presumably due to otitis media which would also account for the perforation of the drum head.

CLINICAL NOTE

RADICAL AND MODIFIED RADICAL MASTOID OPERATIONS WITHOUT A MEATAL FLAP

By M. R. SHERIDAN (Truro)

MANY surgeons prefer, when performing the Radical and Modified Radical mastoid operation, to split the membranous meatus and excise a piece of the cartilage of the concha. This they think necessary to secure adequate drainage and ventilation for the mastoid cavity and to provide access for treatment during healing, or to gain access to the mastoid bone in endaural operations. In the process a troublesome blood vessel may have to be ligatured and quite a time is taken up. Afterwards dressings passed into the cavity over the raw margin of the concha at first cause pain and a large granulating surface within has to epithelialize. Healing takes a great time and at the finish a meatus is left which is not always handsome and sometimes even ugly.

The fine results of the Schwartze mastoid operation with a post-aural incision are well known. There is good access to the operative field, the mastoid cavity rapidly granulates and fills, the drum heals quickly, the dressings are not painful if an oily posterior drain is used, and the healed wound inconspicuous if fine sutures have been inserted close to the skin margin and tied without tension.

It seemed likely that these advantages of the Schwartze mastoid operation might be applicable to the Radical and Modified Radical operation if the membranous meatus and concha were left uncut. The mastoid cavity and antrum should fill and become obliterated by rapid granulation against the membranous meatal tube, from the edge of which only the drum, aditus and deep meatus would require to be epithelialized.

Forty-five successive cases of the Radical operation and ten of the Modified operation were dealt with on these lines. The operation was the usual one through a post-aural incision save that the sleeve of membranous meatus was detached from the superior posterior and inferior walls of the bony meatus, pushed forward and preserved intact. The continuity of its epithelium with the tympanic membrane was broken close to the membrane. Bone was freely removed always including the posterior meatal wall and the bridge whether the drum membrane and ossicles were left or not. The posterior wound was sutured completely and the meatus filled down to the tympanum with half inch ribbon gauze smeared with B.I.P.P. Experience showed that posterior drains, as in the Schwartze, were unnecessary as drainage into the meatal tube along the gauze, was complete and trouble free. Four days after the operation gauze soaked in flavine emulsion was used in the meatus and thereafter daily till a fortnight after the operation. It was then discarded and the meatus was merely mopped clean and boric acid powder blown inside till healing was complete. Provided that the initial packing was carried out the meatus never became narrowed or stenosed, but was rather wider than the normal ear channel.

Clinical Note

The mastoid excavation was always effectively obliterated, so that no awkward recess ever existed

In comparison with the more usual operation with a meatal flap, some advantages were apparent. Bleeding was less troublesome. Dressings were much less painful and were easier to do. The meatus discharged very much less during healing and often scarcely at all. These last two advantages are due to the absence of any large granulating surface uncovered by skin. Patients found less difficulty in mopping out the meatus at home, though in many cases they did not need to mop at all. Healing time was shorter, taking between four and seven weeks. The proportion of completely epithelialized cases in the Radical operation was higher, being forty out of forty five cases. In none of these forty cases was there wax, debris or other evidence of incomplete healing or external otitis. Eustachian discharge persisted in five cases. In the Modified Radical operation eight out of ten completely healed. Discharge persisted from the drum in two cases. The normal appearance of the external ear was preserved.

The results seemed to confirm a previous suspicion that accurate and sufficient removal of bone is the most important part of the operation and that preservation of the soft parts unchanged and obliteration of the mastoid cavity are rational things to aim at

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLOGY AND SECTION OF LARYNGOLOGY

COMBINED MEETING

June 4th, 1943

JOINT DISCUSSION No. 7

Chairman—F. C. ORMEROD, F.R.C.S. (President of the Section of Otolaryngology)

Discussion on the Influence of Vitamins and Hormones on the Physiology and Pathology of the Ear, Nose and Throat

By SIR EDWARD MELLANBY

I CANNOT claim any special clinical knowledge of otology but, in the course of my experimental work, some observations on the labyrinthine capsule and its contents were made which may serve as an introduction to this discussion.

There is at present no well-founded evidence that vitamin deficiency is an important factor in any of the clinical conditions found in otology. This, however, cannot be regarded as a final judgment. We have as yet only scratched the surface of the subject of nutrition, and, in view of other facts, it would be strange if some important relations, at present unknown, between nutrition and morbid conditions of the ear, nose and throat did not come to light.

Had we been meeting seventeen years ago, my opening remarks would have been rather different. At that time we had discovered that otitis media could be produced with some regularity in rats by omitting vitamin A from the diet and we then felt that otitis media in children might also be related in some way to vitamin-A deficiency. Now we know that this is not the case. It was just unfortunate that the rat was chosen for this experimental work, since it reacts to vitamin-A deficiency in a particular way by developing epithelial hyperplasia, especially in the Eustachian tube, and this is generally followed by infection in the middle ear and in other places. As far as my knowledge goes, however, rats are the only animals so far tested that react in this particular way, and further experience does not suggest that children are similarly affected, even if their diet is very deficient in vitamin A. On the contrary, you have all seen otitis media develop in children whose vitamin-A intake is very high.

As regards the wider problem of vitamin deficiency, certain writers have said that if nicotinic acid or riboflavin or vitamin B₁₂, etc., were cut out of the diet, defects in the hearing mechanism were produced, and if these substances were given to patients suffering from these conditions an improvement was forthcoming. But other investigators have been unable to confirm these results. Instead, however, of reviewing the literature I shall refer to some experimental work showing the effect of one nutritional factor on the labyrinth which although it may not have any clinical significance at the present time, will no doubt form the basis of future studies on man as well as on animals.

The story started many years ago when I was working on rickets. Some of the experimental animals became very inco-ordinated in their movements,

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a condition which was clearly not a part of the rachitic syndrome itself but evidently had an aetiological basis not far removed from that of rickets.

The differentiation of the original vitamin-A complex, first described by McCollum and Davis in 1913, into two constituents—now known as vitamin A and vitamin D—occupied scientists for a period of many years, and it was not until 1929 that vitamin D (the antirachitic vitamin) was obtained in a pure form, and this was followed in 1931 by the preparation of pure vitamin A. I had found, however, some years earlier, by providing vitamin D alone in the form of irradiated peanut or olive oil and so preventing rickets, that the factor responsible in puppies, young rabbits and rats for the development of the severe inco-ordination was the absence of vitamin A. On examination of puppies thus affected it was found that both the cochlear and the vestibular divisions of the VIIIth nerve showed severe degeneration. Other cranial and peripheral nerves on the afferent side were similarly affected, including the optic, the trigeminal and afferent fibres of the spinal nerves. In addition, widespread degeneration was found in the central nervous system, more particularly in fibres of the posterior columns, and in both direct and indirect cerebellar tracts. Some descending tracts were also involved in the degenerative changes, including the vestibulo-spinal, the posterior longitudinal bundle and the rubrospinal tract. The pyramidal fibres were unharmed. There was also much degeneration in ganglion cells, both peripheral and central. This strange distribution of nerve degeneration in vitamin-A deficiency seemed to have neither rhyme nor reason, but its consistency and the similarity of the reactions of different species of animals made it clear that vitamin-A deficiency produced a definite and fairly clear-cut syndrome.

The clue to the problem was revealed when serial sections of the labyrinth were made. Mr. Hallpike gave me valuable help and guidance in this part of the investigation. The most striking abnormality in the sections of the labyrinthine capsule of vitamin-A-deficient puppies was the overgrowth of the periosteal bone. This overgrowth caused the cochlea to be more deeply placed in the labyrinthine capsule, so that the internal auditory meatus and the nerve were lengthened. In more advanced cases the bone overgrowth was seen to be in both the modiolus and the internal auditory meatus, invading and partially filling the latter, so that in these experiments the nerve was lengthened, compressed, and its course made tortuous by the overgrown bone. It was evident that the pressure of the bone on the nerve was largely responsible for the nerve's degeneration. The cochlear division was most affected, and in some cases the whole of the nerve, including all the cells of the spiral ganglion, had degenerated. The vestibular division, although severely affected, was more resistant than the cochlear division, and cells of Scarpa's ganglion were often squeezed and elongated by overgrown bone and yet apparently functioning. These appearances were in keeping with the known delicacy of the cochlear nerve fibres, which completely degenerate when any part of their course is injured. On the other hand, the vestibular fibres obey the Wallerian law and degenerate only on the peripheral side of the injured point.

There was serous labyrinthitis in the internal ear of these vitamin-A-deficient puppies. This appeared later than the degeneration of the cochlear nerve and was probably unconnected with it. It may have been due to changes

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in the cerebrospinal fluid resulting from bone overgrowth and pressure effects in the posterior fossa. The development of serous labyrinthitis in these animals may be of importance, because it probably determines whether the organ of Corti degenerates. Destruction of the cochlear nerve alone does not produce this effect, but a vitamin-A-deficient animal in which serous labyrinthitis developed showed large degenerative changes in the organ of Corti. There is some evidence, but it is not conclusive, that adding vitamin A to the diet soon after these pathological changes have developed will cure the serous labyrinthitis and prevent degeneration of the organ of Corti, but it will not, of course, restore function to the degenerated cochlear nerve.

The excessive periosteal bone formed in the labyrinth of these animals tends to be cancellous in type and rich in fatty marrow. It was thought possible at one stage of this work that a low calcium intake in the diet might play a part in this bony overgrowth. In experiments made to test this point it was found that, although additional calcium made the new bone of a more compact type, it did not prevent bone overgrowth in A-deficient animals, nor did it prevent the degeneration of the VIIIth nerve by pressure from this bone overgrowth. The olfactory nerve is also involved under these experimental conditions, but not so seriously as the auditory nerve. Vitamin-A-deficiency puppies develop a great thickening of the cribriform plate and the branches of the nerve are squeezed and twisted and some of the fibres are destroyed as they pass through this bone from the olfactory mucous membrane to the olfactory lobe of the brain. The loss of the sense of smell in these animals is reflected in their behaviour, for often they appear to try to make up for its diminution by excessive sniffing. These changes are readily produced in young growing animals (puppies, rabbits and rats), but similar, although smaller, changes are found in adult animals when the experimental period of feeding is increased. Thus, whereas the pathological condition can be produced in three to five months in puppies starting on A-deficient diets at the age of about 2 months, it may take 2 years or more to produce inco-ordination in an adult dog. As would be expected, the more actively growing bone of the young animal is more rapidly affected.

There is evidence that the bone hyperplasia which so seriously affects the auditory nerve and other nervous tissue in vitamin-A deficiency is due to a derangement of osteoblastic and osteoclastic activity. Vitamin A seems to control and co-ordinate the actions of these bone cells and in its absence they do not function properly, so that bones of abnormal shape and texture are produced. Bone is laid down in places where it does not normally develop, for instance in the internal auditory meatus, and in these areas the nerves are damaged by the direct pressure of overgrown bone. In some cases, especially in certain parts of the skull and vertebral column, the normal absorption of bone appears to be suspended or delayed, and here the cranial and spinal cavities remain too small to accommodate the growing brain and spinal cord, so resulting in further gross nervous lesions. This irregularity of bone growth may, therefore, have disastrous results on the nervous system, particularly, as has been seen, on the auditory apparatus.

Whereas vitamin A has this controlling action on the shape of many growing bones, it is of interest to note that its closely associated fat-soluble vitamin—

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vitamin D—is concerned also with bone development, but in this case with the calcification and hardening of osteoid tissue

By DR RAYMOND GREENE

In the embryo, the primitive mouth or stomodæum is formed by the invagination of the epiblast. From its top Rathke's pouch grows upwards between the pre-sphenoidal and post-sphenoidal centres of ossification to meet, at the 4th week, another pouch descending from the IIIrd ventricle of the brain and thus to form the pituitary gland. Thus symbolically, out of the marriage of neurology and otolaryngology, endocrinology is born.

I shall not attempt to discuss the numerous occasions on which the interests of laryngology and endocrinology overlap, for instance in the nasal approach to pituitary tumours, in the important relationship between septic foci in the nasal sinuses and both thyrotoxicosis and diabetes mellitus, in the common occurrence of pituitary tissue in the pharynx, in the endocrine relationships of asthma, or in the effects of androgens on the growth of the larynx and on laryngeal papillomatosis. I propose, too, to give but passing reference to the possible endocrine relationship of otosclerosis—a subject ripe for reinvestigation. The literature produces a depressing effect. There is no settled criterion of diagnosis, there is an unfortunate prevalence of uncontrolled observation and therapeutic optimism. One author claims that otosclerosis is due to hyperparathyroidism on the grounds that he has produced similar lesions by the injection of dihydrotachysterol—which, however, is not the same as parathormone in its actions. Another is equally convinced of the opposite thesis, that he can cure it by the oral exhibition of parathyroid extract—which, of course, is inactive by mouth. There are some interesting and suggestive clues to follow but at the moment we can only echo the words of Albert Gray (1934). There is no evidence whatever of any defect in any of the endocrine glands or their secretions in otosclerosis. Neither is there any evidence of any defect in the bone metabolism of the body. On the contrary, the subjects of otosclerosis are apart from their deafness, perfectly normal individuals with ordinary average health.

Nevertheless, while preserving one's scepticism of theory based on therapy, it is well to remember that every cell of the body is perpetually throughout life in contact with the very potent substances secreted by the endocrine glands. It is unlikely that any system of the body is exempt from their influence. In otolaryngology we see this influence displayed most clearly in effects on bone growth and on the mucous membranes.

We see the effects of the anterior pituitary most clearly in gigantism, acromegaly and pituitary dwarfism. In gigantism, the α cells produce an excessive amount of the growth factor during the normal period of growth. For the most part, therefore, the correct relative proportions are maintained though, owing to the strong chondrotrophic effect of the factor the long bones tend to be disproportionately long. In the skull the normal changes of maturation are often exaggerated. The maxilla of a child consists of little more than the alveolus and the frontal process. As age advances the antrum develops and the vertical height of the bone increases. This normal change is sometimes exaggerated in the giant, producing a typical facies. Abnormal

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development of the sinuses is seen also in acromegaly in which the excessive growth factor produces more obvious deformity because the bones developed in cartilage are no longer capable of growth. A patient of my own well exemplified the disproportionate growth of the mandible and of the soft parts of the face. Enlargement of the larynx gave him an extraordinarily deep voice. The uvula, soft palate, turbinals and nasal mucous membrane were grossly thickened, and his nose, roomy though it was, was always obstructed. His frontal sinuses were huge. In hypopituitary states, underdevelopment of the face and of the nasal sinuses is often seen, though here we have to remember the complicating factor of hypothyroidism which invariably accompanies a general hypopituitarism. The face may be merely infantile owing to a selective deficiency of the growth function, or it may show the broad depressed bridge characteristic of the cretin, due apparently to premature synostosis between the pre- and post-sphenoidal parts of the sphenoidal bone. Again a panhypopituitarism or a selective absence of the gonadotrophic function may both show themselves by the small larynx and high voice of the eunuch.

The effects of the anterior pituitary on the shape of the skull were the subject of Keith's classical work in 1911 and were also observed by Peltsohn (1918) and Escat (1922). They have recently been studied in detail by Mortimer and his associates. Mortimer (1937) found that complete hypophysectomy in the young rat retarded growth of the snout in all directions. The cranial height and width remained normal but the anteroposterior measurements were reduced. The middle table of the skull and the homologue of the frontal sinus were hypoplastic. Similar results occurred in dogs. The effects could be overcome in part by anterior pituitary extracts. Mortimer, Levene and Rowe (1937) extended these observations to man by correlating the X-rays of the skulls of nearly 3,000 patients with their endocrine histories. They divided cranial dystrophies of pituitary origin into four types. Type I showed cancellous overgrowth producing hyperplastic diploe, large sinuses and prognathism. The head is large and the face well developed. An extreme example of Type I is acromegaly. Type II is similar but there is in addition an abnormal sclerosis of bone which the authors correlated with a period of hypopituitarism following one of hyperpituitarism. Type III shows a failure in cancellous and general growth, a small brain case and poor development of the face and sinuses. In its extreme form Type III is the face of the pituitary dwarf. In Type IV there is also hypoplasia, but in addition there is excessive sclerosis and there may be large exostoses on the inner table of the frontal bone. This is the type of skull we see most clearly in the Stewart-Morel syndrome. Mortimer, Wright and Collip (1937) found evidence of such cranial dysplasias in over 90 per cent. of their cases of atrophic rhinitis, and they were impressed by the unusually high incidence of "constitutional deafness" in their series. This term appears to include a mixed bag of juvenile nerve deafness and otosclerosis. An association of atrophic rhinitis and deafness is not clinically obvious, but in the light of the fact that a high proportion of their cases of atrophic rhinitis (and therefore perhaps of their cases of nerve deafness) are associated with calvarial sclerosis, it is clearly important to find out whether calvarial sclerosis is commonly associated with juvenile nerve deafness in general, and this Omerod and I are now attempting. We have been impressed

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by the frequency with which nerve deafness in young people is associated with other changes, sometimes abnormal skull shapes, sometimes (as in the recent case of murder committed by a deaf boy during a hypoglycaemic attack) with definitely endocrine changes. Sir Edward Mellanby has just described the nerve deafness of young animals which results from the bony overgrowth of vitamin-A deficiency. Though there is no evidence of human nerve deafness due to hypovitaminosis A, I do not think that we know enough of juvenile hypopituitary states to dismiss the possibility that nerve deafness may sometimes be caused by bony overgrowth of endocrine origin. The influence of hypovitaminosis on the pituitary even makes it possible that Mellanby and I are discussing identical changes.

The relationship between the mucous membrane of the nose and the mechanism of sex is said to have been known to Hippocrates. The subject was reviewed in 1884 by Mackenzie who observed that the nasal mucosa of women becomes congested at the menstrual period and at suppressed menstrual periods, hence so-called vicarious menstruation. In fact this congestion tends to be immediately premenstrual in time and to be relieved by the flow. Some women, as Hoesason (1938) has pointed out, tend to suffer from rhinorrhoea and asthma at this time, not because these diseases are themselves necessarily of endocrine origin, but because the nose is then peculiarly sensitive. Many women suffer from an annoying nasal congestion during pregnancy and I have observed that such women are often those who suffer from menstrual oedema. Mortimer, Wright and Collip (1936, 1937, 1939) showed that in monkeys there is an increase in colour of the nasal mucosa at monthly intervals coincident with the swelling of the sexual skin. The nasal changes were 8 per cent. more regular as a sign of sexual activity than menstrual bleeding itself. They were most obvious in the fertile months of September and October. Immature and adult monkeys of both sexes, whether intact or castrated, reacted to oestrogenic treatment by reddening of the nasal mucous membrane, which occurs even if the nasal tissue is transplanted elsewhere (Bachman, Collip and Selye, 1936). The papers from the Montreal school were followed by many clinical reports of good results in the treatment of atrophic rhinitis by injections, local application and implantation of oestrogenic substances, and there is little doubt that these reports are founded on fact. The results of treatment are not, however, uniformly good, and, as Safer (1942) has pointed out, the treatment must be regarded as palliative, not curative. All patients relapse after a time if treatment is stopped. It has been pointed out also that many patients are greatly improved by the nasal hygiene which usually precedes the oestrogenic treatment, nevertheless there seems little doubt that improvement may occur without preliminary hygiene provided that gross sources of infection are absent.

The changes of atrophic rhinitis are atrophy and degeneration. The sub-epithelial tissues contain excess of fibrous tissue. The mucous glands are atrophied. The epithelial basement membrane breaks up and disappears and the epithelium changes from ciliated columnar to stratified squamous. There is a scantier secretion of unduly watery mucus and a discontinuity of the mucous sheet. Owing to the absence of cilia, the sheet ceases to move into the nasopharynx and the mucus dries and forms crusts. It is conceivable that improvement might be brought about by increasing ciliary movement, if the cilia have

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not been completely destroyed by the disease process, or by increasing blood supply. As Boyd, Clark and Perry (1941) showed, improvement in ciliary action is in fact brought about by oestrogens (oestrine, oestriol, and oestradiol being effective in ascending order), provided that the doses used are minute. In larger doses, however, depression of ciliary movement occurs. As there seems little doubt that the beneficent effect of oestrogens in atrophic rhinitis is greater with increasing dosage we must look elsewhere for the explanation of the effect. That the changes may be accounted for by the selective concentration of free oestrin in the nose is suggested by the animal experiments of Fisher, Krohn and Zuckerman (1936). The effect of oestrogen is a moderate vasodilatation, as Reynolds and Foster showed (1940). Eagle, Baker and Hamblen (1939) did biopsies before and after treatment. In every case there was a subjective improvement with reduction in the crusts and hyperæmia, but there was no microscopic improvement. Oestrogens have been shown by Hechter, Lev and Soskin (1940) to possess a double action, the specific one which has given them their name and a non-specific power of producing hyperæmia in many tissues. Reynolds (1939) had already shown that the hyperæmic activity of oestrogens is due to the liberation of acetylcholine. With Foster (1940) he showed that there is a local increase in acetylcholine in nasal mucosa treated in this way. Bernheimer and Soskin (1940) have completed the picture by showing that by spraying the nose with prostigmin results may be obtained which are identical in kind with, but according to them more beneficial than, those obtained with oestrogens. In every case, however, the trouble returned when treatment was stopped. The position in atrophic rhinitis may be summed up thus: we are ignorant of the causes of atrophic rhinitis, which may, however, be related to abnormal action on skull growth of the anterior pituitary. The changes in the nasal mucosa are temporarily alleviated by hyperæmia, which can be induced by oestrogens given either locally or generally. Hyperæmia is probably induced by reason of a sexual skin-like power of the nasal mucosa to concentrate oestrin, which there induces an increase in the production of acetylcholine. The process may be simplified by the direct topical application of prostigmin. Whichever method is adopted, the degree of improvement depends largely on the previous treatment of gross sepsis. The treatment, though frequently effective, is palliative, not curative. The underlying microscopical abnormality remains.

In endocrinology the terms physiology and pathology are almost synonymous, for endocrine disorder is almost always an excess or a deficiency of normal function rather than a disease process imposed from without.

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DR J. L. BURN (M.O.H., Salford) described investigations which were proceeding in his area in administration of vitamin A and other vitamins to schoolchildren suffering from defective hearing. So far the individual pure tone audiometric results revealed no significant difference in the vitamin and control groups.

Many practitioners prescribed various vitamins for the alleviation of deafness. A survey of the literature showed, all too often, that cases described were few in number, seldom tested audiometrically, and not adequately controlled. A notable exception was Sir Edward Mellanby's paper in the *Journal of Physiology*, 1938. In humans, however, a significant and sobering fact was that the hearing of severe cases of scurvy, pellagra, a-riboflavinosis and vitamin-A deficiency, were so often within normal limits. Divergent claims and practice suggested the advisability of a large scale investigation adequately controlled by study of similar groups, using pure-tone audiometric methods.

MR R. G. MACBETH gave an account of a short series of cases investigated in February to May, 1943, in order to obtain the vitamin C levels in the blood plasma and leucocytes. The cases fell into two groups (a) those suffering from repeated upper respiratory infections, and (b) those upon whom operations had been performed in an E.M.S. hospital. Major J. Angell James R.A.M.C., had been associated with him in the investigation and had made the bulk of the clinical observations. Messrs J. R. P. O'Brien and G. A. Higgins had carried out the laboratory tests.

The patients were drawn from the Services and from civilian sources, the operation cases being all Service cases. The civilian cases showing the lowest plasma ascorbic acid were largely those engaged in factory work, who took their main daily meal in the works' canteen. The following tables give plasma levels on an average as found in the laboratory of the Radcliffe Infirmary.

The rôle of ascorbic acid in the tissues appeared to be concerned with the production of intercellular cementing substance which was not produced in scurvy and sub-scorbutic states, hence capillaries broke down, infection entered and wounds healed poorly.

"Infection" cases. 35 civilian patients were investigated and of these 19 had a plasma ascorbic acid level below 0.2 mgr per cent. Characteristically

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they gave a history of never having been free from colds in the winter, had persistent sore throats, attacks of laryngitis, and very often headaches. Some had spongy and bleeding gums. They all complained of lack of energy and of feeling out of sorts. In most cases history revealed a grossly inadequate intake of fresh vegetables, or of vegetables badly cooked. Some had major infections in the nasal sinuses, or middle ears, others merely showed congested noses, red and shiny pharynges, cracked lips, and excoriated nostrils. The latter type of case cleared up rapidly after having ascorbic acid for a few days; the former group required appropriate local treatment in addition. 100 to 400 mgr. daily were given for ten to fourteen days (the dosage depending upon the ascorbic acid lack) and a maintenance dose of 50 to 100 mgr. daily was given for a further month.

A severe case of "trench mouth" improved when given alone 1,000 mgr. of ascorbic acid daily, but required arsenical treatment to heal up the ulceration completely.

Twenty Service cases were investigated. Of those, all but one (an officer) had less than 0.1 mgr. per cent. ascorbic acid in the plasma. Their symptomatology was similar to that of the civilian cases, but rather more severe. Where it was possible to take these patients into hospital, they improved rapidly on ascorbic acid therapy.

Operation cases.—It had been noted that in a consecutive series of 70 tonsil operations on Service patients, there were 9 cases of post-operative hæmorrhage—i.e. 13 per cent.—and of these 2 required to be given a second anæsthetic and ligature of vessels. In the same surgeon's civilian experience, with an identical technique, there had been a post-operative hæmorrhage incidence of 2 per cent. among 279 cases.

In 37 Service patients operated upon for septal resection, there had been hæmorrhage and hæmatoma formation in 4—i.e. 11 per cent. In his previous civilian experience with 104 cases of submucous resection there had been 2 per cent. of hæmatoma.

It was then decided that Service cases, treated by operation in an E.M.S. hospital, would provide a series which could be controlled. It was arranged to give one-half of the patients ascorbic acid pre-operatively in a dosage of 1,000 mgr. daily for four days, and to withhold the treatment from the other half. The same surgeon performed all of the operations, and he was kept in ignorance of the group to which each patient belonged. The operations were all performed under general anæsthetic, given by the same anæsthetist, with a standard technique.

Measurements and observations made on the two groups are listed (Table III).

It was also noted how much more cheerful were the premedicated patients and how much more rapidly they recovered. The others were dejected, sleeping badly, sluggish, and poor in appetite.

[Paintings of the tonsil beds of certain cases were then shown.]

It would seem, from this limited series, that there was probably a generalized lowering of ascorbic acid in members of the Forces and in civilian workers in the winter and early spring; and that there was a relation between this and upper respiratory infections and a tendency to bleed.

TABLE I
VITAMIN C LEVELS IN PLASMA AND WHITE CORPUSCLES

Plasma (normal, peacetime)	0.5-1.0 mgr/100 cc	White corpuscles (normal, peacetime)	20-30 mgr/100 g
Plasma (normal, wartime)	0.3-0.6	White corpuscles (normal, wartime)	10-18
Plasma (Services)	0.0-0.24	White corpuscles (Services), 10 cases	2-7

TABLE II
AVERAGE PLASMA VITAMIN C FOR ALL HOSPITAL PATIENTS INVESTIGATED, MG %

1940	1941	1942	1943	
	Jan-Apr	May-Aug	Sept-Dec	Jan-Mar
0.7	0.62	0.34	0.2	0.2
				(Service points)
				0.1

TABLE III
TABLE TO SHOW POST-OPERATIVE BEHAVIOUR OF SERVICE PATIENTS WITH AND WITHOUT ASCORBIC PREMEDICATION

	Tonsils		Sinuses		Septa	
	Treated (13)	Untreated (13)	Treated (4)	Untreated (4)	Treated (6)	Untreated (4)
Plasma ascorbic acid level on admission (mgr %)	0.13	0.05	0.10	0.08	0.09	0.09
Plasma ascorbic acid level on day of operation (mgr %)	0.92	0.07	1.16	0.00	1.34	0.10
Operative blood loss (cc)	185	4165	307	406	66	78
Post-operative blood loss (cc)	27	45	78	102	6	78
Duration of op. (mins)	15	10	45	41	12	19
Duration of post-op. oozing (hrs)	1.6	6.5	2	3.3	3.3	10
Secondary hemorrhage (cases)	0	2	0	3	0	1
Echymosis (cases)	0 slight	3 moderate	1 slight	4 moderate	0	2 severe
		5 slight				
		4 severe				

First day of comfort
Pyrexia (cases)
Otitis media (cases)
Sloughs (cases)

(Nasal breathing)
3rd
0
0

11 thin
2 thick
5 v thick
9 moderate

5th
0
0
3

13th
3
3

The figures in the first 6 lines represent averages for the patients under review

THE BRITISH ASSOCIATION OF OTOLARYNGOLOGISTS

THE new conditions under which members of the medical profession have worked during the past four years have shown the necessity for associations whose purpose is to watch the changes that are taking place and those that may be expected in the future and to make suitable representations to medical and to lay bodies ; this applies not only to the profession as a whole, but to the various specialties.

The need for such an association to represent the special interests of Otolaryngology had not made itself felt in the years preceding the present war but latterly the need for some authoritative group of members of the specialty had become apparent. Possible ways of forming such a group within the framework of an existing organization were examined without success and it became obvious that the need could not be satisfactorily met except by the formation of an independent association of Otolaryngologists.

During the summer of 1943 a letter was sent to the members of the specialty explaining the position. At a general meeting on September 10th the British Association of Otolaryngologists was formed and rules for its conduct were drawn up.

Its function is to watch over and safeguard the general interests of Otolaryngology and Laryngology, to appoint members to confer with those of other similar associations, and to make representations to such other bodies neither lay or medical, as may be necessary. It is not intended that the Association shall organize any clinical or academic activities, nor in any way usurp the functions of the Sections of Laryngology or Otolaryngology of the Royal Society of Medicine.

It was decided at the general meeting that membership of the Association shall be restricted to those who are engaged solely in the practice of Otolaryngology and who shall also satisfy the Council of the Association as to their qualifications for membership.

The officers consist of President, Vice-President, Honorary Treasurer and Honorary Secretary. The Council consists of twenty-four members, this somewhat large number being due to the desire to have represented all parts of Great Britain and Northern Ireland, all those centres which include medical schools, and the medical services of the armed forces.

The headquarters of the Association will be in a house in Lincoln's Inn Fields, which is the property of the Royal College of Surgeons of England and in which accommodation (rented for the purpose) will form the joint headquarters and secretariat of this and a number of similar associations. This arrangement will facilitate liaison between various bodies with similar interests and will enable joint action to be taken where necessary with the minimum of delay.

There is an entrance fee of £1 and an annual subscription of £1 payable on October 1st.

The house in Lincoln's Inn Fields will not be ready until the end of March and the temporary address of the Association is 22 Upper Wimpole Street, W.1. (Tel. Welbeck 4017.)

The British Association of Otolaryngologists

The officers of the Association elected at the first Annual General Meeting are

<i>President</i>	W M Mollison
<i>Vice President</i>	I Colledge
<i>Hon Treasurer</i>	V E Negus
<i>Hon Secretary</i>	F C Ormerod

The members of the Council are the above with

London E D D Davis and F W Watkyn Thomas

Scotland I Simson Hall G Ewart Martin, Robert P Mathers, I H Otty,
Gavin Young

North J I M Black, J H Cobb H V Forster, T Ritchie Rodger, V Lambert,
Donald Watson

Midlands E Musgrave Woodman R G Macbeth

East A S H Walford

West W H Bradbeer, R D Owen, A J M Wright

South T B Jobson, E Cowper Tamplin

Services Brigadier Myles Formby

Northern Ireland Kennedy Hunter

The rules are as follows

1 The British Association of Otolaryngologists is formed to promote the general interests of Otology and Laryngology

2 It shall have a President, Vice President, Treasurer and Secretary, and in addition a Committee of twenty four members

3 Membership shall be limited to those who are engaged solely in the practice of Otolaryngology and who shall also satisfy the Council as to their qualifications for membership

4 Official publications or notices shall appear in the *Journal of Laryngology*, *British Medical Journal* and *Lancet*

5 The entrance fee for membership shall be £1 (one pound) and the annual subscription £1, payable by Banker's Order on October 1st each year

6 The members shall meet annually at such place as the Officers and Committee shall choose as convenient and at such other times as the Committee shall decide

7 A general meeting must be called at any time on the signed request of ten or more members

8 The business of the Annual General Meeting shall include

- (1) Election of Officers and Members of Committee
- (2) Election of New Members
- (3) Presentation of Accounts
- (4) Other business

9 The names of proposed new members shall be submitted to the Committee for nomination prior to election at the Annual General Meeting

Endeavour was made to circulate all members of the specialty at the time of the formation of the Association, but if any who are wholly engaged in the practice of Otolaryngology were inadvertently omitted, the Honorary Secretary would be glad to have their names

ERRATA

VOL. LVIII, No. 8, AUGUST, 1943. In the paper by Bedford Russell, the X-ray photographs shown on Slides 5 and 6 (facing page 333), should be reversed, leaving captions as printed; Slide 4 should be the reverse way up.

The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

November 1943

CONTRIBUTIONS TO FUNCTIONAL PATHOLOGY OF THE EAR—I ON SOME ASPECTS OF TREATMENT IN PROGRESSIVE CONGENITAL DEAFNESS

By F KOBRAK (London)*

In previous contributions we have suggested that there is in progressive congenital deafness a significant alteration in the activity of the intra-tympanic musculature. Further, that this alteration is due to a spastic condition of the muscles secondary to the primary pathological changes in the cochlear nerve.

Taking this as the working hypothesis, in this series of observations we have attempted to alter the abnormal condition of the "nervous system of the ear" by suitable therapy. The phrase "Nervous system of the ear" is deliberately chosen, treatment must be directed not only to the cochlear nerve, but also to the motor branches of the trigeminal and facial supplying the intra-tympanic muscles and to proprioceptive nerves of the muscles, in fact to the whole neural arc controlling these muscular activities.

In such therapy there is no distinction between the two types of progressive congenital deafness, the primary cochlear and the ankylo-stapedial, or "classical" otosclerosis. The interrelated pathology of the two types will be fully discussed in a later paper.

We avoided using any drug which could damage the cochlear nerve. Thus arsenic or strychnine therapy was not systematically worked out. They can be useful whips for the cochlear nerve as camphor is for the

* I wish to mention with gratitude that the expenses were aided by a grant from the Duveen fund.

heart, but we do not know how they cause the temporary improvement, nor can we control their action. Our earlier observations showed that there is a risk of secondary degeneration to a point below the original hearing level when the administration of arsenic or strychnine ceases. Certainly these drugs should not be given over a long period.

As far as the cochlear nerve is concerned calcium and phosphorus are harmless. More than forty years ago Siebenmann of Basle, an outstanding figure in otology, first recommended phosphorus, which he regarded as a specific "anti-otosclerotic" drug, and for a long period, at the beginning of the century, this therapy was used by many good otological clinicians. But the surgical generation of otologists, thirty years ago, were more concerned with treating suppurations than in exercising their brains over the problem of progressive deafness. In this surgical era useful work of the past was forgotten, and during the ensuing years progressive deafness became the Cinderella of practical otology.

The original idea of phosphorus therapy was to change the actual pathological lesion of the temporal bone and was based on the recognized destructive action of phosphorus on bone—an application of homœopathic principles. This implies the possibility of reversing the morphological process; a possibility of which we have never been convinced. We have used phosphorus for more than forty years, more especially during the last twenty years, aiming rather at its effect on muscular metabolism. Calcium has been used with phosphorus, as the metabolism of the two is interrelated, and the alterations in calcium metabolism—e.g. in pregnancy—are known to affect the course of otosclerosis. In these observations calcium has been given in "Osteocalcium" tablets, often combined with Vitamin D. In some cases Vitamin B was tried on account of beneficial effects reported on spastic conditions in other regions. (See particularly Case No. 10.)

The number of cases is too small, and the period of observation too short to justify a report of definite results, especially of conclusive improvements, when we remember the well recognized fluctuations of hearing which occur in this condition without any treatment. But if undue optimism is unjustified so is undue pessimism. The remissions are of prognostic significance. Prognosis for medical therapy seems worse in a stabilized or a steadily deteriorating condition than where there are periodic fluctuations, which may refer to hearing in either ear or to bilateral audition; in the second instance a tendency to bilateral equilibration of hearing may sometimes be seen. (Cases 5, 11, 18, and particularly 22.)

We can safely say in a number of cases a favourable "subjective" effect on hearing was reported by patients. We were satisfied in cases where there was a permanent loss of hearing to find an arrest in the decrease without conspicuous improvement. An arrest over a long period

Contributions to Functional Pathology of the Ear

of observation should be regarded as an active effect in stopping the advance of deafness

In the consideration of hearing "efficiency" the possibility of exploiting the available hearing "sensitivity" is important. Efficiency depends not only on threshold sensitivity but on damping and psychological factors. Also, on compensation. Compensation in a sensory organ when the function of another is failing or lost, is well known. There is also to some extent a compensation in an individual organ when a part of it is more or less out of action, the surviving part adjusts to a new functional situation. But such an adjustment cannot happen while there are continual small changes in function, arrest of an advancing process gives respite to the organ, and a chance of adjustment and compensation.

In a small number of cases (*v* clinical records) favourable results were confirmed by audiometric tests. But we should not attach too much importance to improvement which could be graded within the range of spontaneous change. The possibility of auto-suggestion, "the will to hear" must always be carefully considered. Nevertheless the patient's opinion is important.

Hearing is usually estimated by the threshold figure of pure tones, either of the tuning fork or audiometer, but we must recognize that there are often considerable discrepancies between the hearing efficiency for conversation and the hearing sensitivity for the audiometric readings. These may be explained by the action of a mechanism less important in the threshold sensitivity to pure tones than in the efficiency of the perception of human speech. Speech perception is a complex of hearing activities characterized by the quick flow and combination of sounds of different pitches and of different tone intensities. Adaption to quickly varying tone intensities are attributable to the damping activities of the intra-tympanic muscles. If the hearing to the examiner's spoken voice is improved, without any improvement in the tuning fork or audiometer reading, the scientific doctrine is too apt to say that the patient is wrong. Before accepting this nihilist attitude the otologist should ask himself, in every case, whether, and if so why, the patient is right and the doctor is wrong. This point is of considerable importance in cases improved by inflation, which will be discussed later.

In the measurement of hearing it was found useful to make a rough estimate of "capacity", by an "audiometric index of deafness". The figures of decibel loss are added together and divided by the number of tones heard. Thus, if, e.g. only six tones of the eight available on the 2 BE Western Electric Audiometer are heard, and the sum total of loss in decibels is 408 db the index of deafness will read $408/6 = 68$. (Point left from 68 means the lowest tone—most left in the audiogram, point right from 68 means the highest tone—most right in the audiogram—is

lost.) In some of our records "steppage tests" are mentioned. These tests, described in earlier papers, give some indication of the efficiency of the damping apparatus. The interpretation of the figures is as follows: 1,000 d.v. Left $33/12/8/5/0=60$ " means that the first period of hearing is 33 seconds, the second 12, and so on, with four "steps" and a final threshold of sixty seconds. A normal reading would be $95/20/5/0=120$ " or $105/15/3/0=123$ ".

General Therapy against Advance in Congenital Deafness

Not only positive therapy, but also elimination of deleterious factors is important. Poisons of all kinds, relatively harmless to the normal individual, may be dangerous to the hearing in a case of slight congenital deafness, or even to that of a "normally" hearing member of a family in which there is hereditary deafness.

Excessive smoking is a common danger. (A characteristic vestibular response is not rarely found in cases where nicotine has been abused. There is a brisk post-rotatory nystagmus after only two or three slow rotations with a practically normal response to minimal caloric tests.) Here is such a case:

A doctor, aged 45, with a family history of deafness (father and father's mother deaf). Auscultation slightly impaired, tuning fork figures subnormal both ears. A heavy smoker. After two weeks' abstinence from tobacco the hearing on the left was normal and the right slightly improved.

Aspirin is another drug used almost as freely as tobacco. Even in small doses it may damage an ear which is congenitally susceptible, and the damage may be irreversible. This was seen in a case of long-standing otosclerosis of the right ear (Record No. 8). This case is important not only as showing the vulnerability and early involvement of the cochlear nerve in otosclerosis, but also as illustrating the bad effect of salicylates on the nerve. It gives a hint also as to one form of prophylaxis in cases of advancing congenital deafness, by avoiding or controlling the dosage of salicylates. Such an incident must not deter us from using aspirin in special cases. When concomitant "rheumatism" is suspected of playing a part in certain stages and cases of deafness, it is logical to use aspirin against the suspected "rheumatic" component. In one case (No. 20) carefully checked during a stay in hospital and afterwards over many months, an improvement to tuning forks was found, but it was associated with, and afterwards followed by a gradual fall in the audiometric index of deafness. Nos. 3, 8, 14, 19, 20 and 31 are other aspirin cases.

The question of aspirin in the therapy of deafness needs detailed investigation. It seems as though the odds are against the cochlear

Contributions to Functional Pathology of the Ear

nerve, but a little in favour of the tympanic muscles. Probably in special cases or at particular stages of deafness the tolerance of the nerve to salicylates is higher than the threshold of efficiency of salicylate in the tympanic muscles. We have, then, the difficult task of determining and keeping in the range of the two thresholds.

The danger of intense noise is important. This may have serious consequences. This applies not only to typical congenital cochlear deafness, but to the otosclerosis as well. This is not surprising in view of the association between the two. Case No. 15, a definite otosclerosis, only noticed the deafness after being exposed to intense noise in a war factory.

The genetic factor needs special consideration. The recognition of heredity in a case of congenital deafness is only of scientific interest when the patient is first seen, as he usually is, at an advanced stage of deafness. Our proper task is to detect the early and possibly the pre-stage of hereditary deafness. The way of detecting the early and pre-stage of congenital deafness and the attempt to prevent, to some degree, the advance of congenital deafness will be the subject of another paper.

Conclusions

We must admit that it is not possible to alter the basal pathological changes in congenital deafness.

It may be possible to improve the patient's condition by making a new pathway for the sound waves by surgical fenestration of the labyrinth, or by altering two variable factors, pressure in the middle ear and labyrinth, and varying the activities of the intra-tympanic muscles and so of the damping apparatus.

In this research we are dealing only with the alteration of the damping apparatus, but a brief mention should be made of the other methods suggested. Stapesankylosis is, as a matter of fact, an undesirable barrier against air conducted sound waves. On the other hand it can be regarded as a pathological damping which bars or decreases sound of deleterious intensity.

Surgical fenestration can improve the access of sound waves to the organ of Corti; however, we must remember that this alteration of the anatomy of the inner ear must interfere with any physiological or pathological damping mechanism. Taking the long view we must ask whether this added access of sound is of ultimate benefit if we leave the organ of Corti unprotected by the damping mechanism.

The pressure in the labyrinth can be altered by methods that do not work through the damping mechanism, such as extensive thecal puncture, either sub-occipital (Max Meyer) or lumbar (Demetriades, Daito). This has been tried, in conjunction with other therapy, in some of the cases recorded here. (No. 6, 15.)

In discussing the therapeutic improvement of damping we must mention the effect of inflation in some cases of congenital deafness. In some cases, although there is no evidence of tubal obstruction or of any catarrhal condition, hearing is definitely improved for a short period—perhaps a few days, sometimes a few weeks. Inflation was tried on an unselected group of twelve cases of congenital deafness. In some cases hearing shortly after inflation was definitely worse, either by air, by bone, or by both. In some it was unchanged, in some definitely improved. In all cases full audiograms for air and bone were made before and after inflation. In some cases patients with congenital deafness, especially of the cochlear type, have shown improvement to the whispered voice of, say, one to four yards after Politerization, without any improvement in threshold values as recorded by tuning fork or audiometer. Such findings cannot be dismissed as due to "auto-suggestion" by the patient or faulty observation by the otologist. They can be explained as an effect on the intra-tympanic musculature and so on the damping. The differences observed can be explained also on this hypothesis: the "efficiency" not the "sensitivity" is improved.

The tympanic muscles are regarded to operate at a key position of controlling normal and pathological hearing, and, to some degree, of encouraging medical treatment of congenital deafness. The key position is part of the vicious circle: cochlear nerve degeneration—(spastic) hyperactivities in the tympanic muscles—labyrinthine hyperpressure—secondary cochlear lesion. The restricted medical therapy is directed against this vicious circle in one way or another. These are the chances with more or less advanced deafness. More promising seems to be combating the earliest and, even, the pre-stages of congenital deafness. This is the task of special ways of individual and familial diagnosis. The ways of pre-stage individual diagnosis and of hygienic (eugenic) familial diagnosis with congenital deafness will be fully discussed in following papers.

Clinical Record

(1) T. Charl, 28, classical otosclerosis for four years, worse after baby 4 months old. (Case No. 362.)

27.10.42. Right $394/.6 = 65.5$; Left $360/.6 = 60$. Mist. Acid phos. twice, half an ounce, Calc. lact. tablets twice 2.

17.11.42. Right $350/.6 = 58.5$; Left $330/.6 = 55$. Did not attend Hospital once more. Period of observation too short.

(2) L. Lilly, 50, during some deep X-ray treatments of myomata deterioration of hearing. (Case No. 368.)

17.11.42. Right $388/8 = 48.5$; Left $333/8 = 41.5$. Phosphorus and Calcium.

24.11.42. Right $260/8 = 32.5$; Left $241/8 = 30$. The likelihood of an additional condition must be taken into account. No special acute cold was stated.

Contributions to Functional Pathology of the Ear

Otosclerosis was first diagnosed. Some endocrine influences upon deep X ray therapy cannot be excluded. The improvement is too definite in too short a period as to be regarded as an improvement of typical otosclerotic conditions.

(3) G Leon, 22, advanced otosclerosis (Case No 233)

29 4 42 Right $437/7 = 62.5$, Left $426/7 = 61$. Took Strychnine and Phosphorus 6 weeks. Improvement on the average by nearly 5 decibels. No further treatment.

1 12 42 Right $469/7 = 67$, Left $469/7 = 67$. Phosphorus and Calcium and Vitamin D.

22 12 42 Right $469/7 = 66$, Left $466/7 = 66.5$. Calcium and Vitamin D. No Phosphorus (stomach).

5 1 43 Right $496/7 = 71$, Left $449/7 = 64$. Aspirin twice a day 2.5 grains.
26 1 43 Right no test, Left $369/6 = 61.5$. The formula shows two pitches missing this time additionally pitch 4096 which means a loss of at least 93 decibels. This would mean a loss of 369 plus at least 93 decibels or of 462 decibels. Formula $369/6$ substituted by $462/7$ expresses therefore no improvement against $449/7$. Now for some weeks for special professional reasons no therapy.

15 3 43 Right $444/6 = 74$, Left $476/7 = 68$. Mist Strychnine and Phosphorus tried again.

10 4 43 Right $388/6 = 64.5$, Left $451/7 = 64.5$. Case illustrates some temporary improvement by Strychnine and Phosphorus.

(4) H Isabel, 13, cochlear deafness. Mother classical otosclerosis (Case No 229)

15 7 41 Right $437/8 = 54.5$, Left $443/8 = 55.5$. No therapy.
16 4 43 Right $410/8 = 51$, Left $443/8 = 55.5$. Yeast tablets thrice a day 2 and Marmite. Fluctuating figures $4/6$ and $20/8$. Last test on
3 12 43 Right $413/8 = 51.5$, Left $469/8 = 58.5$.

(5) B Stephen, 15, incipient otosclerosis (Case No 371)

1 12 42 Right $236/8 = 29.5$, Left $359/7 = 52.5$. Phosphorus and Calcium and Vitamin D.

29 12 42 Right $126/8 = 16$, Left $352/-44$. Same therapy. January 15th to 26th.

26 1 43 Right $165/8 = 20.5$, Left $361/8 = 45$. During the next period Mumps no therapy.

12 3 43 Right $165/8 = 20.5$, Left $395/8 = 49.5$. Now thrice 2 tablets yeast except short pauses.

30 7 43 Right $182/8 = 23$, Left $433/8 = 54$. Goes for holidays, no therapy.

14 9 43 Right $234/8 = 29$, Left $397/8 = 49.5$. For special reasons no further medical therapy.

16 10 43 Right $209/8 = 26$, Left $471/8 = 59$. Patient goes abroad. The case is a certain illustration on what was said in the paper on the spontaneous ups and downs and on the tendency of equilibration in binaural audition in the course of progressive hereditary deafness (*vide* period especially between $30/7$ and $14/9$, but also between $14/9$ and $16/10$).

(6) A Horace, 30, otosclerosis noticed five or six years (Case No 150)

27 2 40 Right $287/7 = 41$, Left $345/7 = 49$. No therapy.

15 12 42 Right $404/7 = 58$, Left $475/7 = 68$. Mist Strychnine and Marmite.

F. Kobrak

5.1.43. Right $384/7=55$; Left $445/7=63.5$. The same until 26/1. Then stopped (stomach).

23.2.43. Right $384/7=55$; Left $464/7=66.5$. No medical therapy.

20.4.43. Right $376/7=53.5$; Left no test.

12.7.43. Right $421/7=60$; Left $482/7=69$.

28.9.43. Extensive lumbar puncture of about 40 c.c.

8.10.43. Right $398/7=57$; Left $443/7=63$.

5.11.43. Right $387/7=55.5$; Left $469/7=67$.

31.12.43. Right $406/7=58$; Left $473/7=67.5$. Last deterioration Right due to deterioration with pitch 4096. Slight improvement might be attributed to extensive lumbar puncture, but apparently without any permanent use.

(7) P. Harry, 56, cochlear deafness. Took some previous months, at periodical intervals, a Strychnine mixture, feels subjectively worse. (Case No. 303.)

22.12.42. Right $371/8=46.5$; Left $347/8=43.5$. Phosphorus plus Calcium and Vitamin D.

16.3.43. Right $335/8=42$; Left $307/8=38.5$.

15.4.43. Typical Ménière attack.

19.4.43. Giddiness definitely gone.

20.4.43. Right $312/7=44.5$; Left $331/8=41.5$. Yeast tablets thrice 2 and Marmite.

23.6.43. Right $338/8=42$; Left $350/8=44$. The same therapy.

10.8.43. Right $340/8=42.5$; Left $363/8=45.5$. Practically standstill both ears during 8 months. Ménière attack did little, if any, harm in both ears.

(8) G. Sidney, 32, otosclerosis. Right ear gradually deaf for years; Left "good". (Case No. 383.)

Audiometric Hearing Index: 19.1.43. Right $487/7=69$; Left $242/8=30$. Prescription: 4 times a day 2.5 grains Aspirin, for severe rheumatic troubles. Came, by mistake, after 4 weeks only, and took certainly more Aspirin than ordered.

16.2.43. Right $547/7=78$; Left $337/8=42$. Aspirin stopped. Yeast and Osteocalcium tablets.

23.2.43. Left $370/8=46$.

Patient had to join the Forces again, and was not seen since. But this is, undoubtedly, a striking example of the disastrous effect of Aspirin, especially in the good left ear of a case of hereditary deafness. The left ear was indeed fairly good apart from slight cochlear deafness. In the right ear there was typical advanced Otosclerosis. The slight cochlear deafness, Left, was regarded as first stages of Otosclerosis. The patient took Aspirin for rheumatic troubles about 5 grains, three or four times a day, over a period of four weeks not attending the clinic sooner although warned to do so. Meanwhile his good left ear had become definitely much worse, and as shown by another test at an interval of a week (*vide* above the notes of 16/2 and 23/2) irreversibly. In the right ear the old characteristic otosclerotic deafness was certainly worse. But the real catastrophe occurred in the good left ear. It showed originally a negligible slight cochlear type of deafness only. Now, after Aspirin, a definite cochlear deafness seemed to be established. In the audiometric hearing index of the left ear there was a deterioration from 30 to 46, that means a deterioration in five weeks of more than 50 per cent. A certain degree of improvement might be hoped for, a definite recovery would seem to be unlikely.

Contributions to Functional Pathology of the Ear

This case is a significant document not only of the vulnerability or even early participation of the cochlear nerve in otosclerosis but also illustrates the bad effect of Salicylate on the cochlear nerve

(9) M. Hilda, 25, cochlear deafness for ten years (Case No 387)

29 1 43 Right $473/8=59$ Left $286/8=36$ Thrice a week Politzerization
Deterioration after a cold left

19 3 43 Right $473/8=59$ Left $322/8=40$ after Politzerization $292/8=36$ 5
Patient did not attend any more

(10) I. Phyllis, 29, otosclerosis (Case No 389)

Figures of Steppage Test in 1943 (February)

250 d v Right $18/4$ $5/0=22$ 5 1 000 d v $13/5/5$ $5/3/0=25$

250 d v Left $12/9/0=21$ 4 000 d v $13/5/3/0=21$

Admission at Hospital 30 4 43 Oestrogen Injections 30/4 and 2 5 43 Steppage Tests on

4/5 250 d v Right 18 $5/0=18$ 5 1 000 d v 30 $8/5$ $5/0=43$ 5

4 000 d v $18/6$ $5/0=24$ 5

250 d v Left $22/0=22$ 1 000 d v $35/12/8/5/0=60$

4 000 d v $19/3/0=22$

Vitamin B Injection on 4/5

5/5 250 d v Right $24/0=24$ 1 000 d v Right $33/12/0=45$

4 000 d v $16/6/4/0=26$

250 d v Left $21/0=21$ 1 000 d v $40/11$ $5/0=51$ 5

4 000 d v $19/2$ $5/0=21$ 5

Second Vitamin B Injection on 5 5 43

6/5 250 d v Right $25/8/0=33$ 1 000 d v $38/13/0=51$

4 000 d v 18 $5/5$ $5/4/0=28$

250 d v Left $24/0=24$ 1 000 d v $42/11$ $5/6$ $5/0=60$

4 000 d v $20/5$ $5/0=25$ 5

Audiometric Hearing Indices

2 2 43 Right $469/8=58$ 5 Left $432/8=51$

17 8 43 Right $443/8=55$ 5 Left $449/8=56$

9 11 43 Right $450/8=56$ Left $449/8=56$

The improvement in the steppage test figures in the right ear was obviously due to Vitamin B injections. To be accurate it must be reported that this improvement was not maintained. Six weeks after discharge from hospital the steppage test figures were checked though under unfavourable circumstances on a morning after war work during the night. The improvement had almost disappeared. This case is not quoted as a therapeutic success. But we may deduce from it where the opportunities for medical therapy lie and some cases might be less refractory than this case was.

(11) H. Beatrice, 44, cochlear deafness, about thirty years (Case No 393)

11 2 43 Right $401/8=50$ Left $388/8=48$ 5 Phosphorus and Calcium and Vitamin D

24 3 43 Right, $385/8=48$, Left $418/8=52$ Alternative fluctuation Right/Left within the range of spontaneous ups and downs

(12) B. Else, 66, cochlear deafness forty years.

18.10.40. Right $457/8=57$; Left $378/8=47$. No treatment.

26.2.43. Right $464/8=58$; Left $323/8=53$. Yeast tablets thrice a day 4.

2.4.43. Right $431/8=54$; Left $409/8=51$.

(13) D. Maggie, 29, otosclerosis. (Case No. 399.)

9.3.43. Right $287/8=36$; Left $279/8=34$. Osteocalcium tablets and Vitamin D.

9.6.43. Right $309/8=38.5$; Left $293/8=36.5$.

(14) H. Lillian, 43, classical otosclerosis more than ten years, rheumatism. (Case No. 402.)

23.3.43. Right $480/7=68.5$; Left $552/8=65.5$. Twice 2.5 grains Aspirin.

29.3.43. Right $495/8=62$; Left $433/7=62$. Thrice 0.5 grain Aspirin.

10.4.43. Right $495/8=62$; Left $467/7=66.5$. Twice 2.5 grains Aspirin and 4 Yeast tablets a day.

21.4.43. Right $512/8=64$; Left $512/8=64$. Since then Yeast tablets, on the average thrice 3 tablets.

Control tests June, August, November, 1943; last test

8.2.44. Right $548/8=68$; Left $558/8=70$.

(15) L. Lilly, 21, otosclerosis. Last year much worse. Works in a war factory exposed to intense noise and to straining conditions (night work). (Case No. 404.)

23.3.43. Right $502/7=72$; Left $519/7=74$. Yeast tablets thrice 2 tablets.

6.4.43. Right $343/6=57$; Left $368/6=61.5$. Phosphorus and Calcium and Vitamin D.

27.4.43. Right $423/7=60.5$; Left $436/7=62.5$. The same treatment.

22.6.43. Right $486/7=69.5$; Left $453/7=64.5$. Throbbing noises especially Right "terrible".

Owing to further deterioration Admission at Hospital.

20.7.43. Right $556/8=69.5$; Left $547/7=78$.

During next days rest in bed and three injections of Vitamin B.

28.7.43. Right $504/7=72$; Left $472/6=78.5$.

Next days no improvement. On 7.8.43 extensive lumbar puncture ca. 45 c.c.

13.8.43. Right $418/6=70$; Left $497/7=71$.

17.8.43. Right $404/6=67.5$; Left $402/6=67$.

14.9.43. Right $382/6=63.5$; Left $382/6=63.5$.

9.11.43. Right $382/6=63$; Left $389/6=65$.

This case is highly suggestive of being deteriorated by intense noise, and, at least temporarily, improved by extensive lumbar puncture. The coincident prevention of professional noise might have been co-operative. The effect of lumbar puncture occurred after three useless injections of Vitamin B. This is a case opposite to the patient reported in the paper as having responded only to Vitamin B injections. Favourable period of Yeast treatment 23/3 to 6/4.

(16) S. George, 28, otosclerosis noticed three years. (Case No. 405.)

23.3.43. Right $377/8=48$; Left $375/8=47$. Osteocalcium tablets twice 2 tablets and Halibut oil. Two control tests in June and August, 1943.

26.10.43. Right $449/8=56$; Left $434/8=54$. Certificate for a noise-free job.

Contributions to Functional Pathology of the Ear

1244 Right 375/7=53 5 Left 372/8=46 5 Hearing improved no noise free job available

(17) P Marjorie 33 classical otosclerosis four or five years (Case No 407)

30343 Right 462/8=58, Left 504/8=63 A certain period Yeast tablets later Yeast tablets alternately with Osteocalcium tablets Four control tests in April July August October 1943 Last test

21144 Right 468/8=58 5 Left 495/8=67

(18) H Marion 64 otosclerosis many years gradually worse (Case No 411)

6443 Right 354/5=71 Left 468/6=78 Six Yeast tablets three Osteocalcium tablets a day

2643 Right 309/5=62 Left 430/6=71 5 Ten Yeast three Osteocalcium tablets a day

78743 Right 465/7=66 5 Left 449/7=64 Same therapy

121043 Right 426/6=71 Left 446/6=74 5 Same therapy

75144 Right 388/6=64 5 Left 466/7=66 5 Classical ups and downs during (owing to ? in spite of ?) therapy Noteworthy a period of equilibration in binaural audition between June and July On the whole certainly not worse during nearly ten months

(19) B Agnes 73 sister of the next case Deaf ca ten years Otosclerosis Severe rheumatism

Owing to the good effect in the case of her sister Aspirin was tried with her as well Thrice a day 2.5 gram After four weeks definite deterioration upon tuning fork tests The hearing situation was restored under Osteocalcium and Halbut

Right ear only poor residua of hearing Left ear first test 13443 418/7 60

71143 Last test Left 427/7=61

(20) B Mary, 71, deafness gradually worse especially during the last year Headache, giddiness attacks rheumatism Cochlear deafness (Case No 373)

81242 Right 355/8=44 5 Admission at Hospital 2143

2143 Right 305/8=38 Six times 5 grains Aspirin first four days then four times 5 grains Aspirin Several control tests

26143 Right 377/8=46 5 Owing to the fact that the patient states her hearing was much more distinct than it ever was during the last year without Aspirin further that her head was never so free than it was now under Aspirin and finally owing to the fact that in spite of the worse audiometric figures the tuning fork tests (steppage test) showed initially a definite improvement of hearing efficiency in the right ear the concession was made to take smallest doses of Aspirin another four or six weeks Later a further gradual small deterioration of threshold hearing in the right ear was noticeable but not severe enough to stop the administration of Aspirin which proved to be of benefit for the prior bad rheumatic conditions of the patient Furthermore there was no change in the left ear during the whole period of observation (last tests 8244) Meanwhile the patient had several Ménière attacks apparently upon cerebral arteriosclerosis without any

the hearing. Maybe the permanent doses of twice a day 2.5 grains Aspirin is a little above the threshold of tolerance of the cochlear nerve. On the other hand there are certainly spontaneous ups and downs in this case demonstrated during the period 8.12.42 to 2.1.43, i.e. before the medical therapy started. Therefore it is impossible indeed to distinguish the artificial from the spontaneous component in the course of deafness.

(21) E. Williams, 50, cochlear deafness gradually worse since the last war. (Case No. 413.)

- 13.4.43. Right $300/6 = 50$; Left $292/6 = 48.5$. Mist. Strychnine.
 2.6.43. Right $298/6 = 50$; Left $381/7 = 54.5$. Yeast tablets thrice 3 tablets and Marmite.
 12.7.43. Right $285/6 = 47.5$; Left $288/6 = 48$. Same therapy.
 8.8.43. Right $264/6 = 44$; Left $276/6 = 46$.

(22) B. Nelly, 56, years ago Ménière attacks, now otosclerosis. (Case No. 415.)

- 21.4.43. Right $492/6 = 82$; Left $390/6 = 65$. Yeast tablets and Marmite.
 16.6.43. Right $377/4 = 94$; Left $308/6 = 51.5$.
 18.8.43. Severe buzzing left ear since this morning.
 18.8.43. Right $426/5 = 85$; Left $448/6 = 74.5$. Yeast tablets.
 Noises left gradually decreasing since a fortnight on

24.9.43. Right $431/5 = 86$; Left $379/6 = 63$.
 The decision, whether the improvement during the first period of observation is a spontaneous up in the left ear and a spontaneous down in the right ear, is left to the criticism of the reader. In any case, with therapy or without therapy, the same phenomenon can occur: the tendency towards equilibration in binaural audition. As the patient in earlier years had certainly typical Ménière attacks, probably in the right ear, we can assume that similar changes have now occurred in the left ear. According to Hallpike's findings, a hydrops in the left internal ear is suspected, here, with pressure mostly in the cochlea, less in the vestibular part. It cannot be said whether the hydrops is primarily intralabyrinthine, or primarily retrolabyrinthine and secondarily only intralabyrinthine.

(23) Mrs. K., 50, cochlear deafness. Gradually deaf for years after being exposed to intense noise, some years ago. (Case No. 420.)

- 7.5.43. Right $522/8 = 65$; Left $519/8 = 65$. Twelve Yeast tablets a day.
 11.8.43. Hearing subjectively definitely better.
 11.8.43. Right $447/8 = 56$; Left $440/8 = 55$. Same therapy.
 7.12.43. Right $445/8 = 56$; Left $435/8 = 54.5$.
 This case seems to be highly suggestive of being improved by Yeast therapy.

(24) P. Nello, 37, otosclerosis, gradually worse last year. (Case No. 423.)

- 7.7.43. Right $447/8 = 56$; Left $457/7 = 65.5$. Yeast tablets and Marmite.
 24.8.43. Right $352/7 = 50$; Left $477/8 = 59.5$. Same therapy.
 10.12.43. Right $417/8 = 52$; Left $498/8 = 62$.
 Probably spontaneous ups and downs. Period of observation too short for decision, whether under therapy a tendency to some improvement is noticeable.

Contributions to Functional Pathology of the Ear

(25) Z Doris, 26, otosclerosis, worse after being exposed to several bomb explosions (Case No 428)

18 6 43 Right 375/8=47 Left 440/8=55 Osteocalcium tablets 1st
Halibut oil

Slight ups and downs in July August October 1943 Last test

25 1 44 Right 367/8=46 Left 431/8=54 So far practically unchanged

(26) G Jessie, 50, otosclerosis, ten years deaf

Right ear practically unchanged with slight ups and downs Left ear

29 6 43 554/7 =79 Halibut oil

20 7 43 436/6 =73 Osteocalcium tablets and Halibut oil

14 9 43 477/7=68 Same therapy

9 11 43 410/6 =68 5 Same therapy

1 2 44 460/7 =66

(27) McD Cecilia, 31, incipient otosclerosis

Average figures

Right ear 7 6 43 5 7 43 7 12 43 resp 34 34 33 Osteocalcium tablets

Left ear 7 6 43 5 7 43 7 12 43 resp 37 30 29 Halibut oil

(28) M Dorothy, 29, otosclerosis (Case No 475)

4 8 43 Right 422/8=53 Left 455/8=57 Osteocalcium tablets Halibut oil

7 9 43 Right 406/8=51 Left 431/8=54 Same therapy

2 11 43 Right 440/8=55 Left 470/8=59

Small ups and downs No therapeutical effect

(29) D Walter, 35 otosclerosis, blue scleres Left gradually worse many years, Right lately only (Case No 492)

14 9 43 Right 383/6 =64 Left 377/6 =63 Yeast tablets Marmite

17 12 43 Right 358/6=60 Left 379/6=63 Same therapy

Period of observation too short in any case there is a slight change only in the more recently affected Right ear

(30) L Clara, 40, otosclerosis, since last pregnancy seven years ago (Case No 551)

14 1 44 Right 491/8=61 Left 552/8=69 Osteocalcium Halibut oil

1 2 44 Right 466/8=58 Left 444/7=63 5 Same therapy

Period of observation too short to say that there is an improvement here

(31) J Edward 43, otosclerosis rheumatism vegetative neurosis (Case No 374)

21 1 43 Right 437/6=73 Left 436/6=73

Admission at Hospital For four days five times 5 grains Aspirin No deterioration no improvement Discharge from Hospital Twice a day 5 grains Aspirin

9 3 43 Right 461/6=76 Left 438/6=73

No change Left slightly worse Right Nevertheless thrice a day 5 grains Aspirin After one short control test another full test on

20 4 43 Right 344/5 69 Left 408/6=68 Thrice 2 5 grains Aspirin

F. Kobrak

2.6.43. Stomach does not stand Aspirin any longer. Had ulcer ventriculi some years ago. Aspirin stopped. Instead thrice a day 2 Yeast tablets.

12.7.43. Right $375/.6=62.5$; Left $438/6=73$. Right ear some improvement under Aspirin. During the last period Yeast. It is not the place here to discuss why the effect of Aspirin and Yeast on the muscles could be similar.

Survey of Medicaments Administered

Strychnine: Cases No. 3, 6, 7, 21.

Phosphorus: Cases No. 1, 2, 3.

Phosphorus plus Vitamin D: Cases No. 5, 7, 11, 13, 16, 17, 18, 19, 25, 26, 27, 28, 30.

Vitamin B: Cases No. 4, 5, 7, 10, 12, 14, 15, 17, 18, 21, 22, 23, 24, 25, 29.

Aspirin: Cases No. 3, 8, 14, 19, 20, 31.

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CLINICAL RECORD

GRANULATING MYRINGITIS

AN UNUSUAL AFFECTION OF THE EAR DRUM

By T/MAJOR A J MOFFETT R A M C

GRANULATIONS in the external auditory meatus associated with various types of otitis externa are by no means uncommon. They may be found in the superficial part of the meatus after the rupture of a furuncle, and are associated in the deeper part of the meatus and on the drum with desquamative otitis externa and other types of inflammation¹. In a number of cases examined upon the plains of Northern India a myringitis characterized by the appearance of granulations upon the drum and not associated with either otitis media or externa has been observed. The condition is not always recognized as a myringitis. Of the thirteen cases in this series two had been previously examined by Aural Specialists, the presence and site of the granulations noted and the cases diagnosed as a chronic suppurative otitis media. As the significance of the condition was not immediately apparent to me, I do not doubt that I have upon occasion made a similar diagnosis.

Eleven of the cases occurred in Indians, two in Europeans, all male adults. Both the Europeans had been in India for about two years. The accompanying Table gives an indication of the frequency of the disease compared with other aural conditions.

TABLE I
THE FREQUENCY OF AURAL DISEASE IN INDIANS AND EUROPEANS

	Middle Ear Diseases with or without Otitis Externa	Otitis Externa	Granulating myringitis	Total of all E N T Cases
Indians	209	89	11	527
Europeans	156	131	2	824

HISTORY

In one case the condition was absolutely symptomless, being discovered in the course of a routine examination. The symptoms to be described refer to the remaining twelve. Where a history was obtained it varied from a few days to eighteen months, but in view of the fact that symptoms may be entirely absent it is impossible to say how long the disease may have persisted before it became sufficiently severe to attract the patient's notice. The condition was unilateral in five cases.

Clinical Record

SYMPTOMS.

Aural Discharge. Every patient complained of aural discharge, always scanty in amount and never sufficient to run out of the ear.

Deafness occurred in eight cases varying from a slight dullness of hearing to a severe deafness of the middle-ear type.

Pain is not a marked feature. It was present in five cases and was neither severe nor persistent.

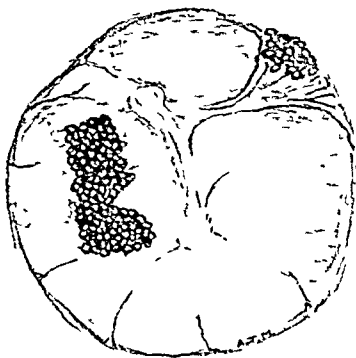
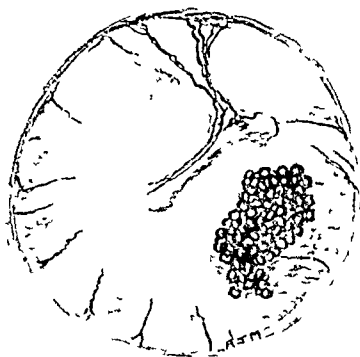
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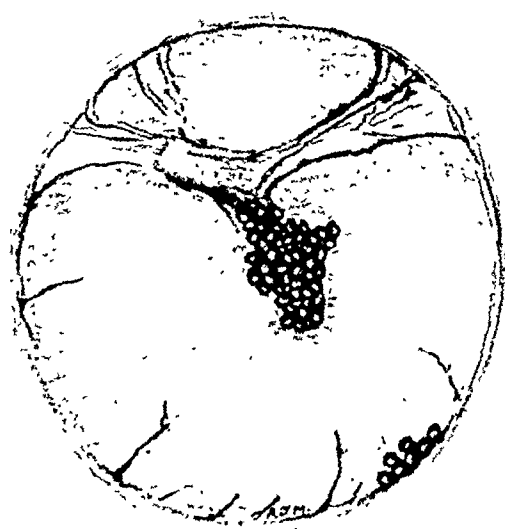
In the depths of the meatus a little creamy pus is found through which the granulations on the drum may be peeping, the appearance immediately suggesting a chronic suppurative otitis media. It is only by a most careful cleansing of the meatus that the true condition is brought to light. In a country where otitis externa occurs but a little less frequently than middle-ear disease (which holds the pride of place among ear and throat conditions) the absence of any meatitis in any of the cases described is a noteworthy feature.

The Drum. With the exception of the granulating areas about to be described the drum is remarkably normal. The upper part may be a little injected with a leash of vessels running on to the handle of the malleus, while a few radial vessels are often present about the periphery. The remainder of the drum is a little pinker than normal and sometimes gives the impression of bubbles or a tiny quantity of exudate behind the lower part. Some remnant of the light reflex is usually visible unless the granulations occupy the position where it is found. The granulating areas may occur anywhere on the drum but are most common immediately in front or behind the handle of the malleus, or on the periphery of the drum in the posterior and inferior regions. More than one patch of granulations may occur. These areas are always well defined, the absence of any marked congestion of the surrounding drum or of vessels running into them being a constant finding. The appearance of these granulating areas is typical. The granulations are minute, always bright red and completely sessile, suggesting the knots upon a thick red woollen rug. There is no tendency to form pedunculate masses. When the Siegles speculum is used the drum is found to be fully mobile, the plaque of granulations moving with it. No perforation can be demonstrated nor discharge withdrawn from the middle ear.

Differential Diagnosis. The condition is most likely to be confused with chronic suppurative otitis media. Unless the meatus is cleansed completely and the drum examined with a Siegles speculum it is impossible to say that the granulations are not produced by a middle-ear inflammation. The absence of any demonstrable perforation, the free movement of the drum with the granulations upon it, and the failure to obtain any additional secretion on suction, indicates that the drum is intact and the middle ear but little affected by the disease.

The absence of pain and the freedom of the meatus from any marked inflammatory reaction is usually sufficient to differentiate granulating myringitis from otitis externa. The granulations sometimes found in desquamative otitis externa are present during the subacute stage. If pedunculated they have a peculiar parboiled appearance, but the type usually found is





really a denudation of the swollen and inflamed epithelium on or around the drum. The outline of these granulations is difficult to distinguish and there is considerable inflammation of the surrounding drum.

Among certain types of Indian patients various other appearances which require consideration may be noted. These are artifacts produced by attempts to simulate or cause disease in the ear. Ecchymoses on the drum or posterior wall, produced by probes or other purposes are not uncommon. Various juices and particles of vegetable matter, placed in the ear in an all too successful attempt to produce inflammation are frequently found. Among some of the other substances used to simulate disease, axle grease, blood from other sources, native tobacco, cigarette ends, chewed meat, chewed bread, flour and water, sand, sputum, semen and assorted small articles have been removed and identified.

TREATMENT

Absolute cleanliness of the meatus is essential if any progress is to be made in the treatment of this or any other external meatal condition. Irrigation from a douche can or gentle syringing is the only way in which the meatus can be sufficiently cleansed and a proper sight of the drum obtained. Swabbing, however gentle, is often painful. Pus if wiped off leads to denudation of the epithelium of the meatus and drum and may produce granulations. Irrigation solution, however, can be soaked up on a wisp of cotton wool laid in the meatus, and it is by this method that the anterior meatal recess so often a reservoir of infection in external meatal inflammation can be made absolutely clean and dry. The subsequent application chosen is of less importance than cleanliness.

The granulations show a high degree of resistance to treatment. The solution of lead and aluminium acetate recommended by Daggett² for the treatment of desquamative otitis externa, while fulfilling his claims for its efficacy in that condition is without any marked effect upon this. Chromic acid 90 per cent was used in the first two cases. It is too powerful an escharotic and in one case produced a perforation in the drum with a mild otitis media which fortunately rapidly subsided. Silver nitrate 10 per cent is the routine treatment now adopted. It is applied at intervals of two or three days, the meatus being thoroughly cleansed before each application. Within three days the granulations lose their bright red appearance. They then become pink, gradually shrink in size and finally disappear. Healing is sometimes accompanied by hyperæmia of the surrounding drum but this disappears quickly when the healing is complete. It is usually necessary to continue treatment for ten to fourteen days.

PROGNOSIS

The condition has usually healed under treatment without any complications. A white opaque rather thickened scar marks the site of the granulations when healing is complete. It was possible to review only one case after a lapse of several months. No abnormality of the drum could then be detected. Perforation of the drum has occurred in one case due, it is considered, to the treatment rather than to the disease. Nevertheless cases not in this series

Clinical Record

have been observed in which an appearance very suggestive of granulating myringitis has been noted associated with a chronic suppurative otitis media. The presence of occasional bubbles and the suspicion of exudate in the middle ear indicates that some reaction occurs in the tympanum. It is likely that in untreated cases this may be sufficiently severe to produce suppuration with perforation of the drum.

Hearing. The permanent effect upon the hearing varies considerably. In some cases it has been very severe, in others even during the active stage of the disease it is unnoticed by the patient and scarcely demonstrable by ordinary clinical methods. Patients appear to have their hearing either greatly affected or not at all. There do not seem to be any intermediate stages. Attempts to improve the hearing by inflations after the granulating condition has disappeared have met with some success.

PATHOLOGY.

The discharge was examined bacteriologically in seven cases. The results are recorded in Table II.

TABLE II.
BACTERIOLOGICAL FINDINGS IN SEVEN CASES

<i>B. Proteus</i> (Pure Culture)	2
<i>B. Pyocyaneus</i> (Pure Culture)	1
Atypical Coliform Organisms (Pure Culture)	2
Atypical Coliform Organisms; <i>Staph. Albus</i>	1
Diphtheroids, <i>Staph. Albus</i>	1

There is nothing unusual about these organisms. They reflect fairly accurately the findings of a large series of cultures taken from the ear and the antrum. A minute granulation was curetted in one case from the edge of the drum. A histological examination did not disclose any unusual features. So far I am unable to offer any suggestions as to the cause of this condition.

I am indebted to Major Stuart McDonald, R.A.M.C., for these bacteriological and histological findings.

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SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF • LARYNGOLOGY

November 5th, 1943

President—W M MOLLISON, M Ch

Discussion on Pain in Laryngology

PRESIDENT'S ADDRESS

W M MOLLISON, M Ch

IN laryngology the position of pain is sometimes a guide to the affection of the underlying tissues but often this is not so, the pain being referred remotely. Sir Thomas Lewis in his recent book on *Pain* makes an interesting observation on the antrum. Briefly, stimulation of the mucous membrane of the antrum was made through the opening made by a radical operation. The stimulation was electrical. In about eight minutes a little smarting was felt in the region of the malar process and lower eyelid. Gradually the whole face became hyperalgesic, a small part of the temple, the ala of the nose and the skin of the upper lip. This diagram (Fig 1) shows the area. The same result was obtained if the nerves to the teeth were stimulated. A just perceptible flush appeared too. An exactly similar area of hyperalgesia was set up by catarrh of the antrum in this patient.

The Vth nerve is very apt to refer pain from the deep structures.

(a) Reference may be made from one branch to another of the same division. The common example is the reference of pain from the lower teeth to the ear. It is stated that pain is never referred from one side to the other but I have seen one case in which pain from a right lower carious premolar was felt in the left ear so severely as to keep the girl awake for two nights. Extraction of the tooth immediately relieved the pain. Incidentally, most of us must have been annoyed to find how difficult it is to decide whether pain is in the suspected lower molar or its opposite number in the upper jaw.

(b) Reference from a branch of one division to a branch of another division. This is the more common. Teeth again supply examples, a carious lower canine sometimes gives rise to supra-orbital pain. I have seen one case in which a carious lower molar not only gave rise to earache but also to pain behind the eye, extraction relieved both. I felt that the eye pain must have been due to reference along the orbital branch of the second division supplying the periosteum of the orbit.

The commonest example is supra-orbital pain from antral infection. Another cause of referred supra-orbital pain is less recognized or at any rate

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seldom mentioned, that due to acute tonsillitis or pharyngitis ; not only is pain experienced along the course of the nerve but hyperæsthesia too.

Pain due to affection of the sphenoidal sinus is frequently referred to remote parts of the head, e.g. to the occipital area, behind the ear and the top of the head ; apparently the nerves involved are the meningeal branches from the Gasserian ganglion ; the occipital pain must be felt *viâ* the tentorial nerve ; the post-aural *viâ* the branches that pass from the ganglion backwards to enter the petrous bone and supply the mastoid antrum and cells. On one occasion I saw a doctor who complained of pain behind and above the ear ; owing to the previous removal of the middle turbinal the ostium of the sphenoidal sinus was easily visible ; on touching with a probe the lower edge of the ostium he pointed to a small spot behind and above the pinna where he felt pain.

On another occasion I saw a case of acute sphenoidal sinus suppuration in which the pain over the mastoid was so severe that mastoiditis was suspected, and on account of very high temperature and rigors, lateral sinus thrombosis too. The local signs were so slight that referred pain was suspected ; exploration of the sphenoidal sinus revealed pus and drainage relieved the symptoms and cured the patient.

Since the Gasserian ganglion appears to supply sensation to the deep tissues as well as to the skin, removal might be thought to prevent all pain over that side of the head. However, Lewis mentions that it has been suggested that pain paths from the deep tissues may not arise from the ganglion ; that parts of the face appear sometimes to respond painfully to deep pressure though the skin was rendered insensitive by division of the sensory branch in the Vth nerve ; but H. M. Davies failed to find evidence of deep pain sense in cases in which the Gasserian ganglion had been removed. Recently I have seen a case which supports the first contention ; the ganglion had been removed on account of trigeminal neuralgia involving the first and second divisions ; the neuralgia had started after a radical antrum operation and later an external fronto-ethmoidal had been performed. After removal of the ganglion the patient had been free from pain for two to three years ; she then began to have pain in the area of the fronto-ethmoidal scar which was tender ; the wound was opened and pus found and the pain relieved. The skin of the whole of that side of the face and forehead was insensitive to touch.

From experience in a number of cases of migraine I am convinced that removal of the anterior end of the middle turbinal cures certain cases of supra-orbital pain indistinguishable from migraine in position and character, irrespective of whether Sluder's suggested *vacuum* theory is correct.

The IXth nerve appears to be even more apt to refer pain remotely ; the statement that a lump in the neck and a piece of wool in the ear is diagnostic of growth in the deep pharynx is as true as any sweeping generality. It is at any rate true that pain in the ear (without local change) may be the only indication of a carcinoma of the aryepiglottic fold. The pain in the ear so common after tonsil removal is a typical example of referred pain along the IXth nerve.

In the œsophagus : the pain of a growth or impacted foreign body is often referred, either to the suprasternal notch or epigastrium even though the lesion is in the middle of the tube.

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WILFRED HARRIS The three sensory cranial nerves to which it may be associated with pain are (1) The geniculate branches of the VIIth nerve, derived from the pars intermedia Wrisbergi (2) the Vth or trigeminal nerve, and (3) the IXth or glossopharyngeal nerve

Geniculate zoster may be extremely painful, the pain being accompanied by the typical herpetic rash on the posterior wall of the auditory meatus and even on the tympanum in the cleft between the pinna and the scalp and inside the mouth, along the side of the tongue and on one side of the hard palate This distribution of the zoster rash is likely to be accompanied by loss of taste on that side of the tongue and palate I well remember the first case I saw many years ago which was referred to me by Dr William Hill, whom some here may remember He was puzzled by the blood stained discharge from the ear accompanied by considerable pain that was complained of by another St Mary's man, an Infirmary Superintendent in the country Dr Hill syringed out the ear with a resultant excessive increase of the pain, which lasted for several weeks In some cases facial paralysis accompanies geniculate zoster, indeed it is surprising that it does not always do so when we recall the intimate relationship of the motor VIIth nerve to the geniculate ganglion which may be looked on as the posterior root ganglion of the facial nerve and comparable to a spinal root ganglion Very rarely persistent otalgia or geniculate neuralgia may be a sequel of zoster or even of chill to the ear without an herpetic rash

Glossopharyngeal tic douloureux is a rare but violently painful affection exactly comparable in character and severity with trigeminal tic though its frequency is perhaps not more than 1 to 500 cases of the latter The pain may be spontaneous, or evoked by the act of swallowing or by touching the tonsil and is referred to the throat and ear, the latter probably through the nerve of Jacobson and just in front of the ear at the back of the mandible never to the chin lip or tongue or side of nose as in trigeminal tic The spasms are brief, and are often accompanied by a hawking cough, as if to clear the throat an attempt by the patient to mitigate the pain It may rarely be bilateral and may even be present with trigeminal tic in the same patient A cure may be effected by avulsion of the glossopharyngeal nerve from the jugular foramen after careful dissection, or by dividing the nerve intracranially I have seen severe bouts of pain produced in the throat, associated with intense hyperæsthesia of the skin below the ear in a case of a small recurrent carcinoma of the tonsil ten years after a primary extirpation by the late Sir Charters Symonds I took the case to him and at first he could not believe there was a recurrence but he excised the small growth, the size of a split pea with relief of the pain though a few months later further pain in the neck with numerous cutaneous metastases occurred

Superior laryngeal neuralgia I have seen only a few times once apparently spontaneous, but the common cause is tuberculosis of the epiglottis and larynx

The Vth cranial or trigeminal nerve is responsible for the large majority of neuralgias about the face jaws and sinuses *Intral* infections and abscess cause local pain in the cheek, with tenderness and with an acute abscess the pain reference may spread to the other two main trigeminal branches on the same side, involving the whole territory of the Vth The pain may spread into the neck and down the arm even to the fingers The same may be seen

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in dental neuralgia occasionally, especially with a carious lower, molar, pain deep in the ear being a common reference. This no doubt is produced through the branch of the auriculotemporal nerve, itself one of the three main divisions of the mandibular nerve. This branch supplies the anterior wall of the external auditory meatus and the tympanum too in part, so that when this nerve is anesthetized, as in alcoholic injection of the foramen ovale, the tympanum may be touched without producing the intense sensitiveness that is the normal condition.

It is well known that chronic antral abscess, instead of local pain in the face, may cause recurrent headaches, which I have known last for three years before their cause was discovered.

Frontal sinusitis is likely to be associated with pain referred along the supra-orbital nerve, with tenderness at the notch. External operations on this sinus, besides causing unsightly scarring, may be followed by persistent supra-orbital pain and hyperæsthesia, varying in severity. This pain is rarely relieved by alcohol injection at the notch, and this is a method I now never use. I have recently had under my care a New Zealand doctor who had suffered severely for over twenty years, and had had numerous operations, thirty-eight in all, on the sinuses, including both frontals. To cure his pain it was necessary to inject the inner portions of both Gasserian ganglia, so as to get permanent anesthesia of the forehead and cheeks. Though this appears, and is, a drastic treatment, involving permanent anesthesia of both corneæ, it relieved his pain completely, so that he could sleep in comfort for the first time in twenty years.

Migrainous neuralgia is a name I use for a not uncommon form of pain around the eye and upper cheek and temple, often limited strictly to one side, lasting for a day or two days, sometimes only for an hour or two, or even for as short as ten minutes, so that six or more attacks may occur daily. Unlike ordinary migraine it is never preceded or accompanied by visual spectra, and very rarely by vomiting, though sometimes with nausea. In some patients the common type of migraine in adolescent life changes in the middle twenties or later to migrainous neuralgia. It is really a dural headache, and responds instantly to alcohol injection of the inner half of the Gasserian ganglion. Although occasionally alternating from one side to the other in different bouts of the headache, which may recur daily for three to six weeks, sometimes annually, very often the pain is strictly limited to one side. This is more suitable for alcohol injection. Peripheral supra-orbital injection is usually quite useless, though I have known infra-orbital injection give complete relief for five years. The majority of these sufferers have been seen by ophthalmic surgeons, and glasses prescribed, and in many, operations such as turbinectomies, antral washouts, even up to exenteration of the ethmoid and antra, have been done without relief. Some have been labelled as cases of Sluder's neuralgia, and treatment by cocaineization or alcohol injection of Meckel's ganglion performed. It is possible that sphenoidal sinusitis may account for a few cases of so-called Meckel's neuralgia, as the great superficial petrosal nerve which runs from the geniculate ganglion to Meckel's is in close relationship to the sphenoidal sinus in part of its course.

Chronic neuralgia of the jaws is another troublesome type of facial neuralgia. This affects sometimes the upper, sometimes the lower jaw, and is occasionally

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bilateral The pain is often described as "drawing" and burning, with some shoots of pain, varying in severity but more or less constant The Americans class it as "Atypical Neuralgia", because it differs from true trigeminal tic The pain may appear to start in one tooth, and spread along the jaw as teeth are extracted In a number of cases the pain commences after wholesale dental extractions, in my opinion always a dangerous neurological shock The constancy of the pain, its burning and drawing character, are suggestive of its type, and it is important to recognize it, as any operative procedure aggravates the pain Alcohol injection in particular must be avoided, as the patient then has the numbness to complain of as well as the pain A curious fact is that a small proportion of cases of true trigeminal tic may develop this type of pain some weeks after Gasserian injection or root resection I call it *trigeminal causalgia*, and it is very difficult to relieve Undoubtedly this type is particularly likely to be met with in neurotic subjects, and we must be wary of producing extensive and permanent anæsthesia in such subjects

Trigeminal zoster, usually involving the ophthalmic branch, is one of the most troublesome causes of persistent pain, and may lead to suicide

Malignant growths of the jaws and tongue cause sometimes severe agony over long periods, especially the nasopharynx neoplasms which are liable to cause intense pain along the mandible and tongue or upper jaw

Growths in the maxilla or antrum, ulcerating through the hard palate are very distressing cases, and cause severe persistent pain, but these can often be completely relieved of pain by Gasserian injection Similarly recurrent carcinoma of the tongue and floor of the mouth may be completely relieved of pain by alcohol injection of the foramen ovale

Spasmodic neuralgia of the face simulating trigeminal tic somewhat closely may be produced by *local lesions* of the teeth or even the cheek and facial bones which may have escaped detection for many years (see Fagge's *Principles and Practice of Medicine*, 1886, vol I, p 359) Many dental cases of severe persistent and intermittent neuralgia may be due to caries of the necks of teeth obscured by the gum I remember such a case which had been classed at one hospital as malignant disease and as *tic douloureux* at another, in which X-rays cleared up the diagnosis Pulp stones and exostoses on the roots may also cause difficulty in diagnosis A dentist who was asked to look after a gentleman who suffered violent intermittent pain in one lower jaw went over each tooth with meticulous care on two occasions, and on the second inspection he detected a tiny hole in the first molar at the gum level, and alternate hot and cold water syringing of the tooth gave a sharp reaction of pain He persuaded his patient to allow him to extract the tooth, which on section disclosed a bristle of a toothbrush in the tiny hole, which reached well into the dentine The neuralgia ceased at once after the extraction

True trigeminal tic, or *tic douloureux*, is a disease which, once contracted always recurs at shortening intervals for the rest of the sufferer's life, unless the trigeminal sensory root is divided, or the Gasserian ganglion destroyed by alcohol injection Yet, in its early stages, before the pain develops its typical tic characters, with sudden violent spasms of pain, lasting a few seconds only, though perhaps recurring every two or three minutes, only too often are good teeth sacrificed one by one, or wholesale, in the vain effort to stop the neuralgia

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treatment. He thought that "psychalgia" was the proper name for such conditions. After all, the eye was the part of the body which one regarded as most closely identified with oneself, and if there was referred pain as in psychalgia it was liable to be referred to the eye rather than anywhere else. He had seen a case of apical abscess of the central incisor, but the pain was referred up the side of the nose. When the tooth was removed the referred pain disappeared.

Pain in the ear was commonly connected with the glossopharyngeal nerve, and spasmodic pain occurring in the ear was strongly suggestive of that origin. He presumed that it might be referred through Jacobson's nerve. He could not explain the "one-way traffic". The "ice-cream complex" was very common. It referred to the side of the head after eating anything that was very cold. The reference was presumably up the vagus nerve and thence to the Vth nerve, and so to the various areas supplied by the Vth.

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ACUTE OTITIC BAROTRAUMA—CLINICAL FINDINGS, MECHANISM AND RELATIONSHIP TO THE PATHOLOGICAL CHANGES PRODUCED EXPERIMENTALLY IN THE MIDDLE EARS OF CATS BY VARIATIONS OF PRESSURE

By Air Commodore E. D. D. DICKSON, Squadron Leader J. E. G. McGIBBON,
and Squadron Leader A. C. P. CAMPBELL

CLINICAL FINDINGS (Air Commodore E. D. D. Dickson).

Acute otitic barotrauma is a syndrome which results from difference between the atmospheric and intratympanic pressures whilst flying or during compression or recompression in the Decompression Chamber. This failure to adjust may be due to mechanical, pathological or personal causes and results in a definite train of symptoms characterized by pain, deafness, injection and invagination of the tympanic membrane, effusion or bleeding in the middle-ear cavity and sometimes even by rupture of the drumhead.

It has been known variously as acute aero-otitis (Armstrong), aviation pressure deafness (McGibbon), Eustachian block. To avoid confusion of terms and for statistical purposes the term acute otitic barotrauma has been adopted in the official nomenclature of diseases in the R.A.F.

It occurs most frequently during descent from altitudes and is due to the inadequate ventilation of the middle-ear cleft through the Eustachian tube. During ascent, ventilation of the cleft is a passive mechanism whereas during descent an active muscular opening of the Eustachian tube is required to allow air to enter it. The efficient ventilation of the cleft will depend on the degree of tubal patency and upon the time available for the air to flow up the Eustachian tube. Rapidity of descent *per se* is not a cause, if the tube is and remains patent, though in the presence of a contributory factor it hastens the onset of the syndrome and determines the severity of the symptoms. A narrowed tube, for example,

requires to open a greater number of times than does a wide one during the same period of time in descents of equal speed and steepness. The Eustachian tube is opened by the involuntary act of swallowing, yawning or Valsalva's manœuvre. If during descent this action is delayed or omitted or rendered inefficient by a reduction in the tubal patency a point is reached when the tubal dilators cannot overcome the negative pressure in the middle-ear cleft and the cartilaginous walls of the Eustachian tube become firmly pressed together as descent proceeds. The tube is then said to become "locked" and the condition of otitic barotrauma supervenes.

It may manifest itself during ascent if owing to anatomical inadequacy or pathological changes of the tube air cannot escape from the middle ear with sufficient speed to reduce the intratympanic pressure to that outside the middle-ear cleft.

Briefly contributory factors can be divided under three headings as suggested by Simpson :

1. *Permanent pathological changes in the Eustachian tube.* These contributory factors are essentially those conditions which have given rise to chronic changes in the lining of the Eustachian tube, thereby affecting its lumen. It is not always possible to estimate from the extent of the visible manifestations of past or present disorders in the ear or nose of the damage sustained by the Eustachian tube. For example, marked scarring of the tympanic membranes suggesting an old otitis media may or may not give rise to symptoms. Likewise we have seen cases with extensive sinus infection and polypi capable of tolerating large and rapid changes in altitude without symptoms.

2. *Temporary pathological changes in the Eustachian tube.* The usual one is a head cold which may or may not be complicated by acute sinus infection, or an acute exacerbation of a chronic condition. A recent attack of acute otitic barotrauma will predispose to further attacks if the patient is exposed to changes of pressure before the lining of the middle ear cleft has returned to normal.

3. *Fortuitous factors* not due to any structural changes but brought about by such factors as preoccupation or lack of time or being taken unawares during evasive action. Loss of consciousness from blacking out, or anoxia, or sleep come under the same category. Lastly, failure of attempted ventilation owing to ignorance of the method of performing autoinflation must be kept in mind.

When however no definite predisposing factors are found and no fortuitous reasons can be ascertained a psychological factor must be suspected. The assessment of such cases presents a difficult problem. Slight sensation in the ears on descent may be consciously or unconsciously magnified in order to evade duties which have become distasteful to the individual.

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Symptoms

The disability may affect one or both ears. The main symptoms are pain, deafness, inability to clear the ears, tinnitus and occasionally vertigo. In 100 patients seen by one of us the predominant symptoms were—deafness alone, 31, deafness and pain, 55, deafness and tinnitus 5, deafness and vertigo, 3, and pain alone 6.

The onset of pain may be gradual or sudden and its intensity varies from a dull earache to an unbearable pain which radiates over the side

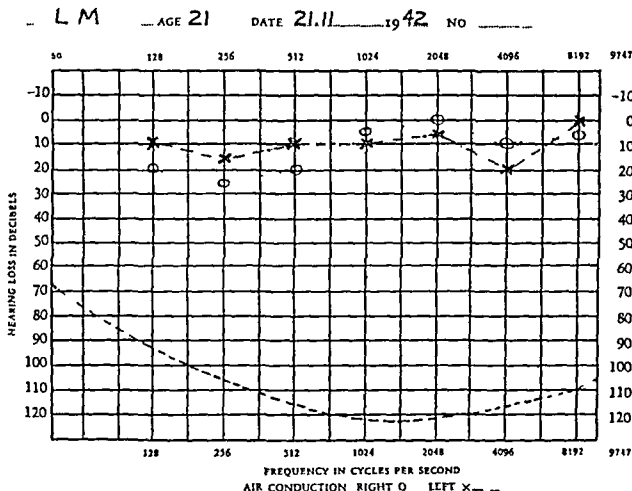


FIG 1

Right Ear Acute otitic barotrauma following a rapid descent from 16 000 ft showing loss for low frequencies. Pain in Right ear persisted till he landed and until next morning. Valsalva negative at first but positive later. Had cold in the head. RMT invaginated and injected with interstitial hæmorrhages. Recovery and normal audiogram in eight days.

of the head and down the lower jaw. It persists until landing is effected and is relieved immediately the intratympanic pressure or equilibrium is restored by autoinflation, catheterization, politzerization or if the aircraft is put into a climb. Severe pain is not necessarily associated with marked physical signs and *vice versa*. We have seen cases with effusion, bleeding in the middle ear and even rupture of the tympanic membrane without any complaint of pain or acute symptoms.

The mechanism of the production of the pain is not clear, though its reception can easily be understood when we appreciate that the tympanum

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is richly supplied with sensory nerves. McGibbon will deal with some of the hypothetical considerations connected with the mechanical side of its production.

Pain which develops during ascent is usually not so severe as that experienced during descent. During descent it may be an immediate result of pressure occlusion or it may occur several hours after the landing—a delayed form of acute otitic barotrauma.

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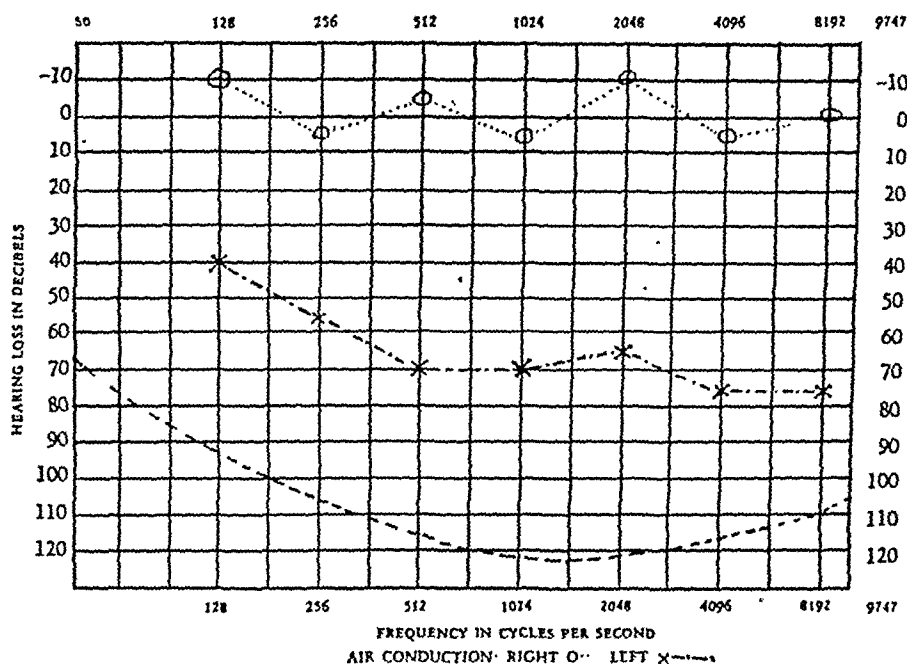


FIG. 2.

Acute otitic barotrauma showing inner ear type of hearing loss. Power dive from 14,000 ft. No pain. Found he was deaf Left ear on landing. Under observation for eighteen months. No change in hearing. Tympanic membrane normal. Valsalva +. Hears shout at 1 ft. Vestibular tests normal.

Deafness, which is a very common accompaniment, is often overshadowed by the more severe sensation of pain. The deafness may become manifest during or after landing from a flight. It may persist for varying periods ranging from an hour or two to several weeks or as long as the intratympanic pressure remains unadjusted or until pathological changes have resolved. This form is usually of the conductive type and audiometrically may show a loss in the low frequencies. More rarely it is acute in nature, and presents the feature of an inner ear or nerve deafness which is often permanent. Vestibular reactions are no



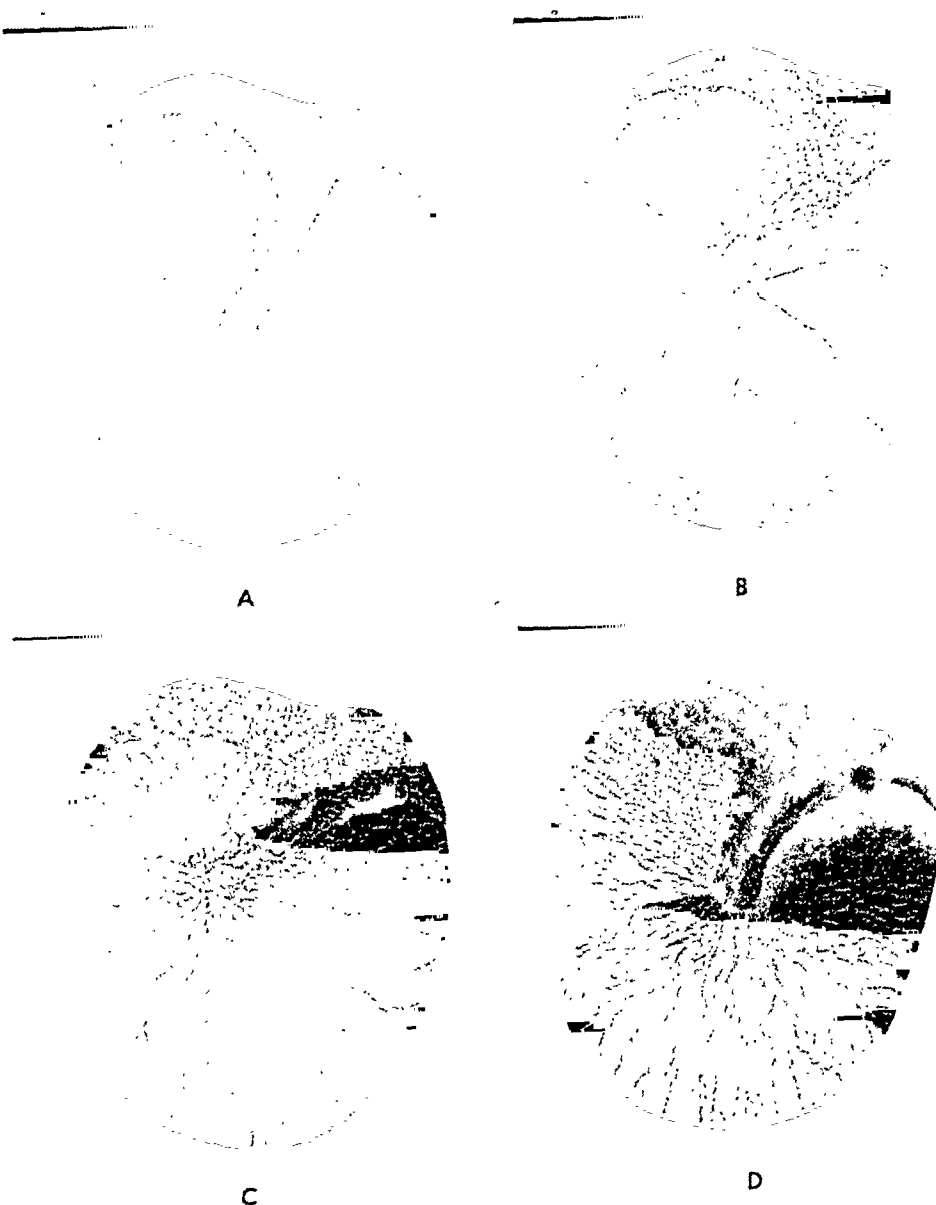
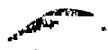


FIG. 3.

Plates showing tympanic membrane changes. (Drawn from actual cases by J.E.G.Mc

- A. —Normal tympanic membrane.
- B. —Invaginated with minimal congestion.
- C —Invaginated with marked congestion.
- D — Attic congestion.



E



F



G



H

I —Generalized congestion

F —Interstitial hemorrhages. Residual hemorrhage usually along handle and in attic

G —Rupture of tympanic membrane. Common site

H —Effusion with patent tube (bubbles). The more common type is with the posterior compartment full

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impaired. Its causation is not known. We are pursuing experimental investigations for any evidence which may account for it.

It is a common finding after a long flight for members of an aircrew to complain of some slight "hardness of hearing" and tinnitus on landing. This is regarded as a normal result of flying and is probably due to temporary auditory fatigue. It passes off within a short period.

A delayed type of acute otitic barotrauma has been noted and is probably due to absorption of oxygen from the middle-ear cavity with a non-patent Eustachian tube. It may occur several hours after landing and is seen in crews who have been using oxygen during long flights—thus raising the percentage oxygen content of their middle ears. During descent they may experience difficulty in adjusting the intratympanic pressure and thus suffer from partial occlusion of their tubes. This occlusion may become complete during sleep as a result of the restoration of normal oxygen-nitrogen ratio by diffusion between the gases in the middle-ear cavities and the blood in the mucosal capillaries. Oxygen being absorbed more quickly than it is replaced by nitrogen and a further fall of the intratympanic pressure takes place and the pathological processes initiated by the pressure differences produced during descent are carried to the point of the development or aggravation of symptoms.

Inability to "clear the ears" is a common complaint and may be due to mucosal changes (congestion or oedema) or the presence of effusion in the middle-ear cavity, even with a patent Eustachian tube.

The existence of a relatively low intratympanic pressure leads to a series of vital changes in the mucosa of the middle-ear cavities and the severity of these changes depends upon the amount of difference between the atmospheric and intratympanic pressures. The amount of atmospheric pressure change brought about by loss of altitude is the important entity. Thus a descent from 30,000 ft. to 20,000 ft., a difference of (123·6 mm. Hg.) is less likely to give rise to the syndrome than a loss of from 12,000 ft. to 2,000 ft. (a difference of 223·4 mm. Hg.). Although the distances are equal the pressure differences vary greatly.

Clinical findings—otoscopic appearances

(a) Invagination of the drumhead of a varying degree, either alone or in association with some congestion in the region of the attic, the handle of the malleus and of the sheaf of vessels which sweep backwards to the posterior malleolar fold. The invagination consists of a pushing in of the drumhead which appears wrapped round the middle-ear contents.

(b) Interstitial hæmorrhages into the drumhead solitary or multiple. They do not form bullae as in myringitis hæmorrhagica. The residual hæmorrhages are often seen after the disappearances of the congestion and run along the anterior and posterior borders of the handle of the malleus.

(c) Effusion into the middle ear. This may be noted at the time of the first examination immediately on landing or from $\frac{1}{2}$ to 10 hours after the onset of symptoms. It occurs more frequently than is recognized and its existence may be concealed by congestion, hæmorrhage or œdema of the drumhead. Absorption of the effusion may take place very rapidly or may persist for 5-7 days. The reason that the mucosa of the middle-ear cleft of patients suffering from acute otitic barotrauma may react either by production predominantly of congestion and œdema or the formation of an effusion and a varying amount of œdema is probably an individual peculiarity of the tissues.

(d) Hæmorrhage into the middle ear, giving rise to a hæmatotympanum.

(e) Rupture of the drumhead. This occurs in the membrana tensa in the posterior or anterior segment. The occurrence of the rupture will depend of course not only on the pressure difference, but also on the condition of the drumhead itself—an atrophic scar is more likely to give way than a healthy intact membrane. The onset is described by the patient as a "crack" or "blow" on the head and is not always preceded by acute pain.

Perhaps a description of personal sensations and the resulting effects produced as a result of induced acute otitic barotrauma in the decompression chamber will help to illuminate some points. During ascent to 10,000 ft. at 1,000 ft. per minute with no attempt to inflate or adjust the intratympanic pressure adjustment was automatic at about every 500 ft. No discomfort, and membrane was seen to bulge out and then snap back into normal position. During descent at 1,000 ft. per minute, dropped from 10,000 ft. to 6,000 ft. before any actual discomfort was noted in either ear. A feeling of "woolliness" in both ears, progressively getting worse and amounting to deafness started at 9,000 ft. Autophony was well marked. Gradual retraction of the tympanic membrane was noted at 8,000 ft. Light reflex shortened, handle of malleus indrawn, and drumhead appears cupped. Injection started at 7,000 ft., first in the attic region anteriorly and slowly spread down the handle of the malleus. At 5,000 ft. adjusted voluntarily as discomfort was pronounced. The tympanic membrane moved outwards and assumed normal position. At this stage the injection was marked resembling a subacute otitis. All symptoms of discomfort and deafness disappeared. The same sequence of events was repeated from 5,000 ft. to ground level. Injection of the tympanic membrane persisted for nearly an hour, but subjectively no appreciable deafness was noticeable.

McGibbon and Allen have carried out a radiological investigation in a series of cases of acute otitic barotrauma and controls to ascertain if any changes such as clouding occurred in the mastoid process. Only cases with equally cellular mastoids were used to arrive at any conclusions. They concluded that direct radiological examination is of no diagnostic or prognostic value in individual patients. It is of interest, however, in that

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it shows that clouding of the mastoid cells when it does occur in association with acute otitic barotrauma requires a minimum of four weeks for its complete resolution

Incidence

Although not spectacular acute otitic barotrauma is a very frequent and disabling "flying accident" One out of every five aircrew personnel referred to one of us was suffering from this disability in some degree or other Analysis of flying casualties in one hospital for over a year showed that 15.8 per cent of those treated was due to acute otitic barotrauma They were referred to the E N T Department on account of aural symptoms which had developed during flight and which constituted a varying degree of disability It is almost impossible to ascertain the total incidence of the condition Many airmen who develop barotraumatic middle-ear changes do not complain of symptoms, either because of the mildness of the discomfort or on account of their keenness to remain on full flying duties

In a series of 1,000 cadets which we have recently examined in the decompression chamber the incidence of acute otitic barotrauma was 8.9 per cent That is 89 cases complained subjectively and showed objective evidence of acute otitic barotrauma This figure, however, does not represent the true incidence of the condition because 27.7 per cent showed injected drumheads with no symptoms and 4.8 per cent injected drumheads with mild symptoms, relieved at once by autoinflation, when subjected to a decompression test

A varying degree of manifest vascular engorgement of the drumhead accompanied by mild or transient symptoms are regarded as barotraumatic change even though the signs and symptoms are not sufficient to constitute a disability

Prognosis

This is good in cases of acute primary otitic barotrauma It is usually due to a temporary contributory factor and the majority make a complete recovery after adequate rest and treatment The time for complete resolution depends on the degree and severity of changes in the mucosa of the middle-ear cleft It may be hours, days or weeks It is important to forbid resumption of any flying before complete resolution of vital changes has taken place we advise ground duties for at least a fortnight after disappearance of all signs and symptoms before resumption of any form of flying

Cases who have permanent changes in their Eustachian tubes, and therefore suffer from tubal insufficiency, present a less favourable prognosis Rapid equalization of the intratympanic pressure with that of the existing atmosphere is impracticable and some limitation as to altitude and type of flying becomes necessary

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Prophylaxis

This is very important and from our observations the most common contributory factors are :

1. Upper respiratory tract infection causing Eustachian obstruction.
2. Ignorance of the method of autoinflation.
3. Neglect to adjust the intratympanic pressure owing to pre-occupation.
4. An incompletely resolved acute otitic barotrauma.
5. Anatomical insufficiency of the Eustachian tube to allow adequate rapid air flow to equalize the intratympanic pressure with that of the existing atmosphere during flight.

Acute infections causing a nasopharyngitis are more prone to give rise to acute otitic barotrauma than chronic ones. Some of the rules formulated by Scott who investigated similar aspects of the problem in 1919 still hold good and if practised would help reduce the incidence of acute otitic barotrauma.

1. Airmen should not fly with an acute cold in the head or sore throat or when unable to inflate both Eustachian tubes at will.
2. Airmen who cannot rely on swallowing for opening their Eustachian tubes repeatedly and rapidly should make a rule of self-inflating the ears by Valsalva's method and should begin to do so at the commencement of descent, repeating the procedure once, say, every 1,000 ft., and not wait until they land.

The usual methods for opening the Eustachian tubes are swallowing mandibular movements, shouting and autoinflation. The last mentioned combined with swallowing is the most reliable and effective, but we must stress that it must be achieved to be of any value. Capability of active ventilation of the middle ear by the patient himself cannot be sufficiently stressed and proof of the success of the manœuvre must be objective. Although air can be forced up the Eustachian tube by catheterization or politzerization it is no criterion that air can be forced into the middle ear by a voluntary effort on the part of the individual himself, especially during loss of height. It is surprising the number of aircrew personnel who are inexperienced in the method of ventilating their middle ears, of the relation of pressure changes, and of the means of producing pressure equilibrium. This applies equally, though perhaps to a lesser degree, to many medical officers. It is important for medical officers to realize the necessity of an objectively confirmed positive Valsalva test rather than accept the candidate's statement of "ability to clear the ears". We consider that the most reliable and constant proofs of air entry into the middle ears are (a) visual observation of movement of the drumhead as shown by alterations of the light reflex ; (b) by auscultation.

From a fairly extensive clinical experience and consideration of the histological changes we have observed in our experimental investigations



Fig. 41

Views of a case of acute otitic barotraumatism (Right ear) sustained 5 to 13 showing clouding of the cells and resolution by 3 11 43 (Wynne)

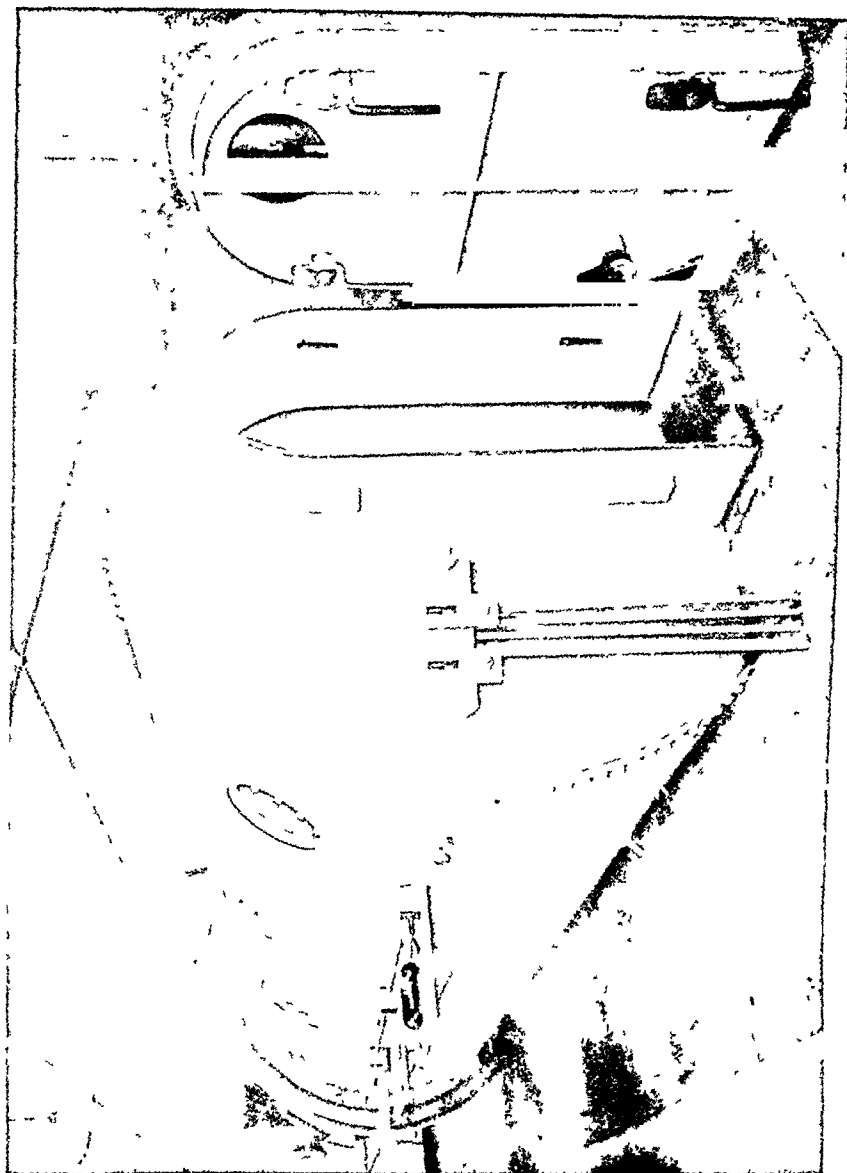


FIG. 6.

Acute Otitic Barotrauma

we are of the opinion that patients suffering from acute otitic barotrauma should be kept off flying until well after the resolution of vital changes and the disappearance of all signs and symptoms.

Treatment

This should be instituted as early as possible with the object of bringing about equalization of the intratympanic pressure with that of the atmosphere. The available methods at our disposal are :

- (a) Valsalva's method alone or in conjunction with swallowing.
- (b) Inflation by Politzer's bag. This is very useful in all cases of acute otitic barotrauma if seen early, and if properly used.
- (c) Inflation through the Eustachian catheter is not advisable unless performed by someone skilled in its use. If successfully performed and sufficiently early it will give relief and arrest the progress of any vital changes.
- (d) Ascent in an aircraft whereby an extratympanic pressure is reached equal to or less than that in the middle-ear cavity.
- (e) Decompression in a chamber which artificially reproduces the condition of ascent in aircraft.
- (f) Inhalations and the application of vasoconstrictors to the ostium of the Eustachian tube have not yielded any striking results.
- (g) Inhalation of helium oxygen in a proportion 20-80 per cent. has been employed in America as a method of treatment with variable success. We have no experience of its use.
- (h) Inhalations of amyl nitrate. Our results are inconclusive although Tomb of Sydney has reported success in two cases of acute otitic barotrauma with relief of the acute symptoms of pain.

If there is evidence of effusion in the middle ear or if relief of symptoms, especially deafness, has not been achieved by active methods stated, owing probably to congestion or oedema of the mucous membrane of the middle-ear cleft, it is advisable to temporize until resolution has taken place. Rest combined with such adjuncts as physiotherapy and the treatment of lesions of neighbouring structures should be undertaken. Chemotherapy is indicated when infection supervenes. Autoinflation by Valsalva's method should be encouraged from the beginning and only when air entry into the middle ear is objectively positive should the patient be subjected to further pressure variations, whether flying or in the decompression chamber. If there is any doubt as to the sufficiency of the Eustachian tube he should be subjected to a decompression chamber under close observation by a medical officer experienced in the changes involved. The tympanic membrane of the patient should be under observation during such a test. We have devised and adopted a standard decompression chamber test in the R.A.F. for the purpose of testing these cases. The efficacy of any treatment administered can be estimated, likewise the genuineness of symptoms.

THE MECHANICS OF THE SYNDROME (Squadron Leader J. E. G. McGibbon).

When considering the mode of production of the signs and symptoms of the syndrome of acute otitic barotrauma, the middle-ear cleft may be regarded as consisting of two differently functioning parts (Fig. 7) :

1. *The proximal membrano-cartilaginous portion (M)*, which has non-rigid walls, and a segment of which acts in a purely mechanical manner as a valve : and

2. *The distal rigid-walled middle-ear cavities (R)*, which consist of the osseous tube (O), the tympanum (T) and the mastoid antrum and air cells (A). It is this portion of the cleft which is affected by the vital changes which are described below.

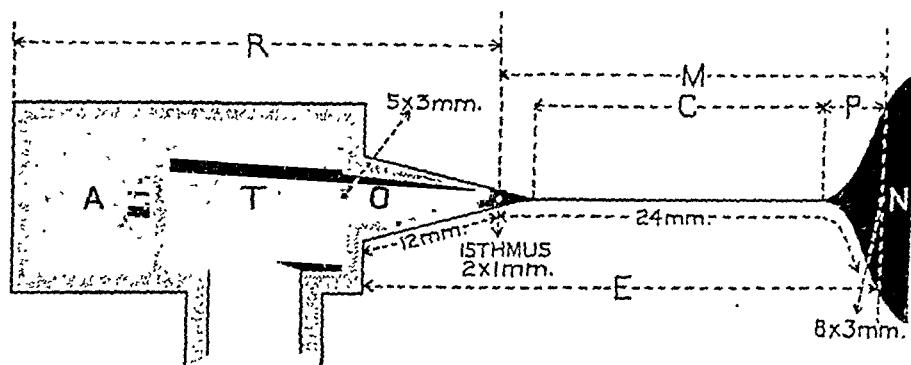


FIG. 7.

Diagram of middle-ear tract to illustrate the two functionally different portions in the production of acute otitic barotrauma.

R.—Rigid-walled cavities—passive function.

A.—Mastoid antrum and air cells.

T.—Tympanum.

O.—Osseous portion of Eustachian tube.

E.—Eustachian tube.

M.—Membrano-cartilaginous portion of Eustachian tube.

C.—Compressible part of membrano-cartilaginous tube—the " flutter " or " flapper valve ".

P.—Nasopharyngeal ostium of tube—funnel shaped and constantly open.

N.—Nasopharyngeal cavity.

1. The proximal membrano-cartilaginous tube has its nasopharyngeal ostium (P) formed like a constantly open funnel. At its tympanic end the walls are attached to the margin of the osseous tube ; so that although this attachment is at the narrowest point of the tubal lumen (the isthmus), it is nevertheless fixed open. Normally the walls of the segment of the tube (C) which is situated between these two open extremities are in contact ;

Acute Otitic Barotrauma

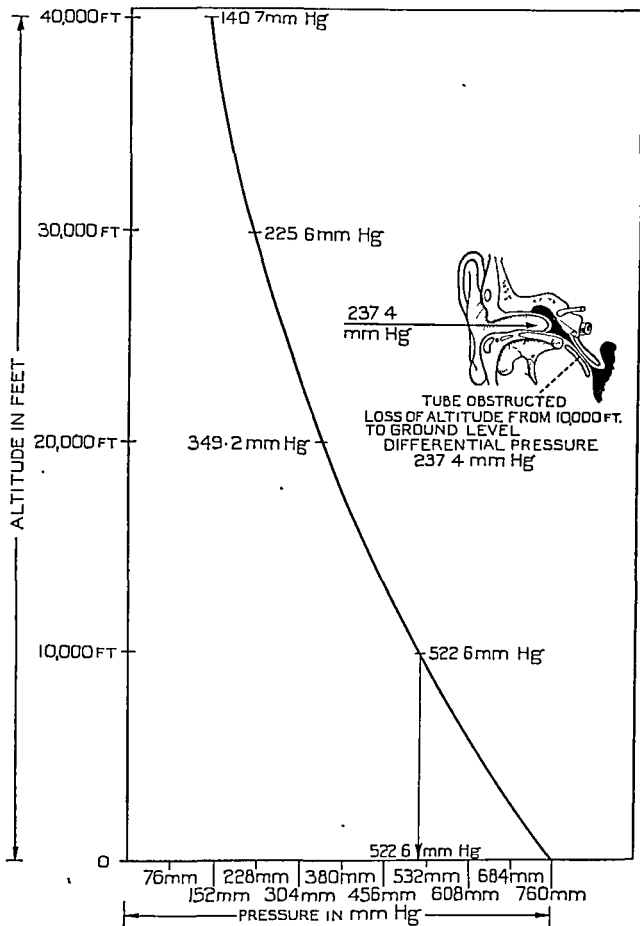


FIG 8

Graph of pressure changes involved in descent from 10,000 ft to sea level—showing the pressures that may be exerted on the middle-ear cleft

J. E. G. McGibbon

and it is the whole or a part of this "compressible" area (C) which acts as a "flutter" or a "flapper" valve.

The valvular action of this "compressible" area is dependent upon a time-lag factor (McGibbon, 1942). If, for any reason, this portion of the tube remains unopened during loss of height in aircraft or compression in a chamber, as soon as the pressure surrounding the middle-ear cleft (i.e. the atmospheric and tissue fluid pressures) is increased a relative rarefaction of the air in the cleft is created and the walls of the "compressible" area are immediately pressed together. As in this way the

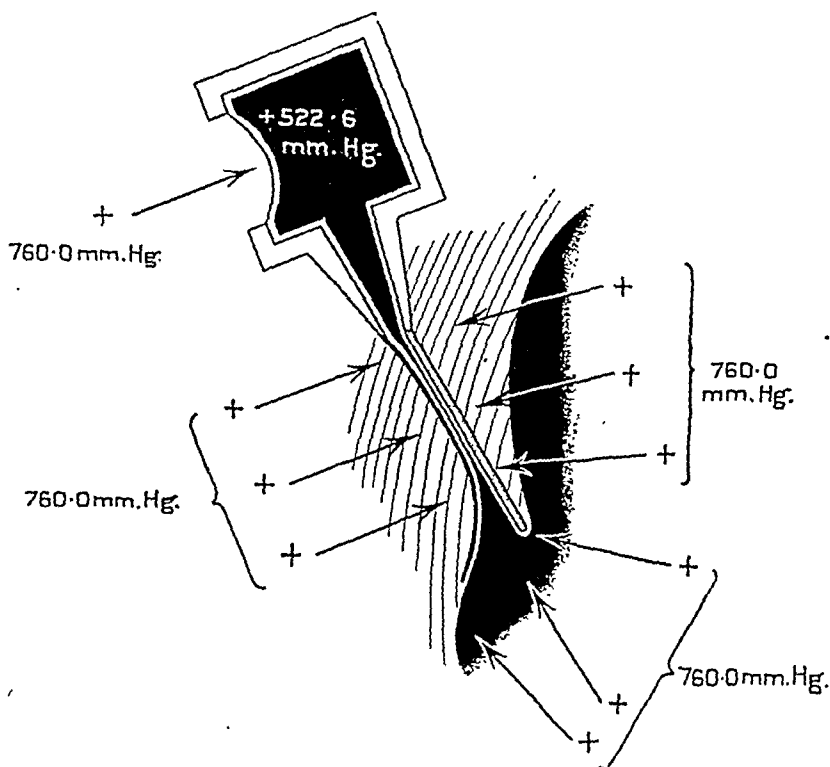


FIG. 9.

Diagram of pressure occlusion of "compressible" portion of tube after descent from 10,000 ft. to sea level.

rarefaction is neutralized more rapidly than it would be by the passage of air from the nasopharynx into the Eustachian tube (i.e. there is a time-lag of air entry into the tube).

In this manner a *primary pressure occlusion* of the tube is produced.

If the tube is not opened physiologically (actively) or by therapeutic means (passively) and if air is not admitted to the middle ear the pressure

Acute Otitic Barotrauma

occlusion becomes firmer as the descent on compression progresses, until finally the occlusive force becomes greater than that which can be exerted by the muscles which normally open the tube. At this stage the tube is said to be "locked". Armstrong (1939) has stated that a negative pressure in the middle ear of about 80 to 90 mm Hg is necessary to cause "locking". However, from clinical and experimental evidence it is clear that no hard-and-fast differential exists at which the tube always locks, and that the necessary "locking" differential varies individually and in the same subject. We have seen an airman who sustained a ruptured drumhead when coming from 2,000 feet to ground level—i.e. when the maximum pressure differential could not have exceeded 53.4 mm Hg.

In order to explain the production of the changes which take place in the distal rigid-walled middle ear cavities as a result of pressure occlusion of the valvular portion of the tube, the effect of a known loss of height may be considered.

If, for example (Fig. 8), an airman descends from an altitude of 10,000 ft (522.6 mm Hg) with an unopened tube, on reaching ground level (760 mm Hg) his middle ear will contain air theoretically at a pressure of 522.6 mm Hg, whilst the pressure surrounding his middle-ear cleft will be approximately 760 mm Hg. Thus he will have a pressure occlusion of his tube of 237.4 mm Hg (Fig. 9)—this figure is not strictly accurate as the difference would be less owing to the invagination of the drumhead.

2. The middle ear cavities of the example cited are shown diagrammatically in Fig. 10. The pressure of the air (D) and of the tissue fluids (F) inside the cavities is 522.6 mm Hg, whilst that of the atmospheric air (A) and of the tissue fluid (E) surrounding the cleft is 760 mm Hg—a pressure difference of 237.4 mm Hg.

The blood supply to the tympanum is carried by vessels which enter the cavity through bony canals (C') or by anastomoses through the drumhead (C''), and the hydrostatic pressure within these vessels is the sum of the existing atmospheric pressure plus the present blood pressure. If the average capillary pressure is regarded, say, as 20 mm Hg in the present example the absolute pressure in the capillaries of C' and C'' will be 780 mm Hg (760 mm Hg atmospheric pressure plus 20 mm Hg capillary pressure), whilst that of the tissue fluid (F) surrounding the capillaries in the middle-ear mucosa is only 522.6 mm Hg. Consequently the vessels become passively engorged. This overdilatation of the vessels by the hydrostatic force acting against the vascular neuro-muscular mechanism is possibly the main source of the pain which is a frequent symptom of the syndrome, and which is therefore analogous to the pain of migraine (Pickering, 1932, Graham and Wolff, 1938). As an additional result of the engorgement of the vessels, blood

or its components is pushed by the relatively high hydrostatic pressure from the capillaries into the tissue spaces of the mucosa (F) and into the cavities (D); and in this manner some of the vital changes—œdema, hæmorrhage and effusion—may be produced.

These vital changes are confined to the middle-ear cavities and they do not affect the "compressible" area of the tube. Nor do they occur suddenly as described. They take place gradually throughout descent

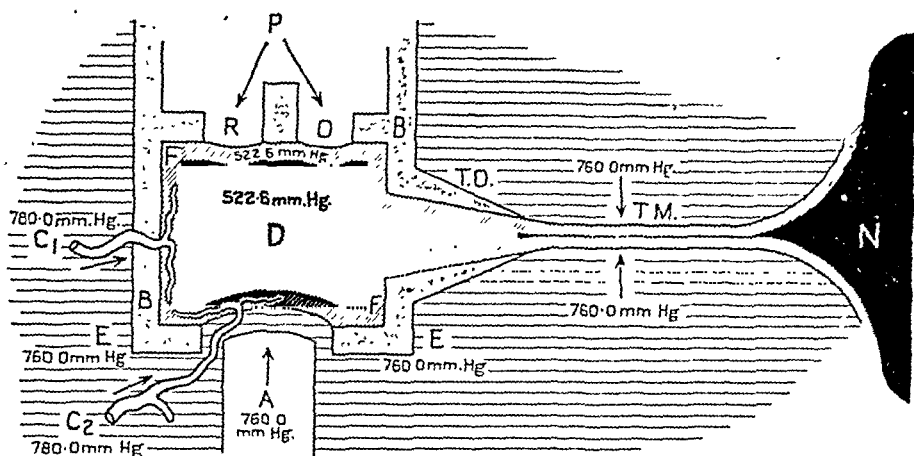


FIG. 10.

Diagram of middle-ear cleft with relatively decreased intratympanic pressure after descent from 10,000 ft. to sea level with an unopened Eustachian tube.

- A.—Atmospheric pressure in external auditory meatus.
- B.—Bony wall of tympanum and ossicular tube.
- C1.—Blood vessels entering middle ear through bony canal.
- C2.—Blood vessels entering middle ear through tympanic membrane.
- D.—Middle-ear cavities.
- E.—Tissue—fluid outside middle-ear cavities.
- F.—Middle-ear mucosal tissue-fluid.
- N.—Nasopharynx.
- O.—Oval window.
- P.—Perilymph.
- T.O.—Osseous tube.
- R.—Round window.
- T.M.—Membrano-cartilaginous tube.

after closure of the tube and the speed of their production depends upon the rapidity of the change of atmospheric pressure.

It has been demonstrated by Thompson and his co-workers (Thompson, Howe and Hughson, 1934) in America that variations of the middle-ear pressure are not communicated to the internal ear fluids; but Hughson and Crowe (1933) have shown that if the pressure of the cerebrospinal



Fig. 11

Photograph of base of cat's skull

The auditory bullae are situated one on either side antero laterally to the foramen magnum

The opening of the osseous Eustachian tube can be seen as a small depression of the antero medial angle of the bulla



FIG. 12.

Photograph of base of cat's skull.

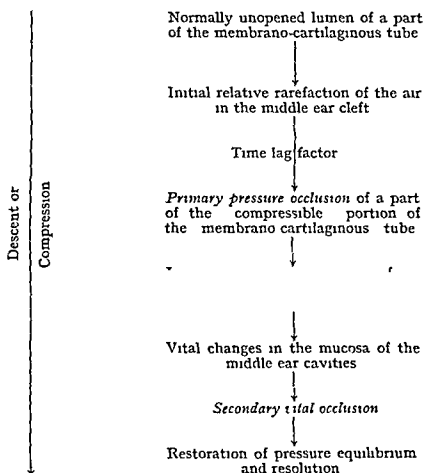
The medial chamber (referred to in our notes as "the bulla") of the cat's Left auditory bulla has been opened by removal of its floor, exposing the bony septum which separates it from the tympanic cavity. The communication between the cavities, and the round window can be seen postero-laterally. The lateral chamber tympanum or middle-ear cavity is also seen opened on the cat's Right side.

Acute Otitic Barotrauma

fluid is raised the membrane of the round window ceases to be concave on its tympanic aspect and that it bulges into the middle ear cavity Dr B H C Matthews, F R S—Director of the Royal Air Force Physiological Laboratory—has kindly informed us that during ascent and descent in aircraft (at any rate below altitudes of 25,000 ft) the relative pressure of the cerebrospinal fluid remains unaltered It is probable, therefore, that in the present example the perilymphatic (P) pressure will be increased in relation to the intratympanic pressure, so that the membrane of the round window (R) will be bulged into the tympanum and the footplate of the stapes (O) will be pushed in as far as the annular ligament will allow

The combined result, therefore, of invagination of the drumhead and movement of the stapes into the tympanic cavity will be a "telescoping" action on the chain of ossicles This ossicular "telescoping" together with the formation of œdema in the mucosal lining and folds of the middle ear may be the cause of the low-tone hearing loss which is characteristic of uncomplicated acute otitic barotrauma

The sequence of changes which occur in the syndrome may be shown as follows



It will be obvious that the effects of loss of height in aircraft or compression in a chamber with an unopened Eustachian tube cannot be

imitated merely by raising the air pressure in the external auditory meatus—a fallacious comparison which has been made by various observers.

Resolution begins when the amount of œdema and effusion is great enough to bring about equilibrium between the atmospheric and intra-tympanic pressures. The tube becomes “unlocked”, and any effusion that may be present is evacuated *viâ* the tube. Even then the entry of air into the middle ear may be prevented either by the degree of œdema of the mucosal lining and folds, or by the presence of effusion which may fill the middle-ear cavity and the tubal lumen. These two types of *secondary vital occlusion* may be demonstrated by the injection of radio-opaque fluid into the Eustachian tube (Rees-Jones and McGibbon, 1941). “Rat-tailed” shadows which are seen in the proximity of the isthmus are probably due to mucosal swelling, whilst “mushroom” shadows which occur nearer to the naso-pharyngeal end of the tube are probably caused by pooling of the radio-opaque fluid on the face of the effusion.

As our experimental investigations have been carried out on cats, a brief comparison is made of the middle-ear cleft of the cat with that of the man.

The middle-ear cleft of the cat consists of a Eustachian tube and an auditory bulla.

The auditory bullae are paired ovoid cavities (Fig. 11) situated one on either side of the basi-occipital bone of the base of the skull. Each auditory bulla is divided by an incomplete bony septum into two communicating cavities (Fig. 12) of unequal size—a small antero-lateral chamber or tympanum and a large postero-medial chamber which will be referred to as the bulla in the description of the pathological changes.

The bulla is smooth-walled, air-containing and it is lined by ciliated columnar epithelium. Its function is unknown, but Professor Wood Jones has informed us that it is an essential part of the mammalian tympanic cavities and that the human mastoid antrum is a vicarious bulla.

The antero-lateral chamber or tympanum is irregular in shape. It also is lined by ciliated columnar epithelium and its contents and their disposition are similar to those of man. Its outer wall is formed mainly by the drumhead, which is covered on its tympanic aspect by low cubical and flattened epithelium without cilia.

The Eustachian tube is 8.5 mm. to 9.0 mm. in length. It can be arbitrarily divided into two segments, an antero-medial two-thirds or “cartilaginous” portion and a postero-lateral one-third or “osseous” portion. The latter is contained along with other structures within a bony canal in the anterior wall of the tympanum. The tube opens into

Acute Otitic Barotrauma

a groove in the anterior extremity of the tympanum, which we have called the "tubal depression". The ostium is slit-like and directed downwards and forwards, it is situated in the lateral wall of the nasopharynx and there is no torus tubae.

The cartilage (Fig 13) extends throughout the entire length of the Eustachian tube and into the tympanum, and consequently there is no definite division into a "cartilaginous" and "bony" portion and no true isthmus.

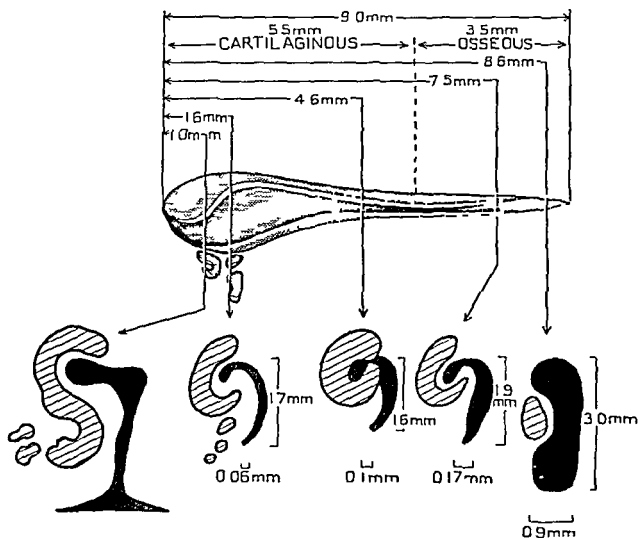


FIG 13

Diagram of reconstruction of cat's Eustachian tube

Owing to the slit-like ostium and to the non-attachment of the cartilage to the osseous tube, the "compressible" area (Fig 14) of the cat's tube is relatively greater than that of man, and as a result the vital changes in the cat do not extend as far along the tympanic end of the tube as they will in man.

The muscles associated with the "cartilaginous" tube are similar to those in man, except that we have not been able to demonstrate a slip

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corresponding to the salpingo-pharyngeus, and the muscles do not gain a direct attachment to the tube in the cat but to the fibrous tissue surrounding the tube.

The muscles appear to act on the whole length of the "cartilaginous" tube in a manner similar to that in man (McGibbon, 1942).

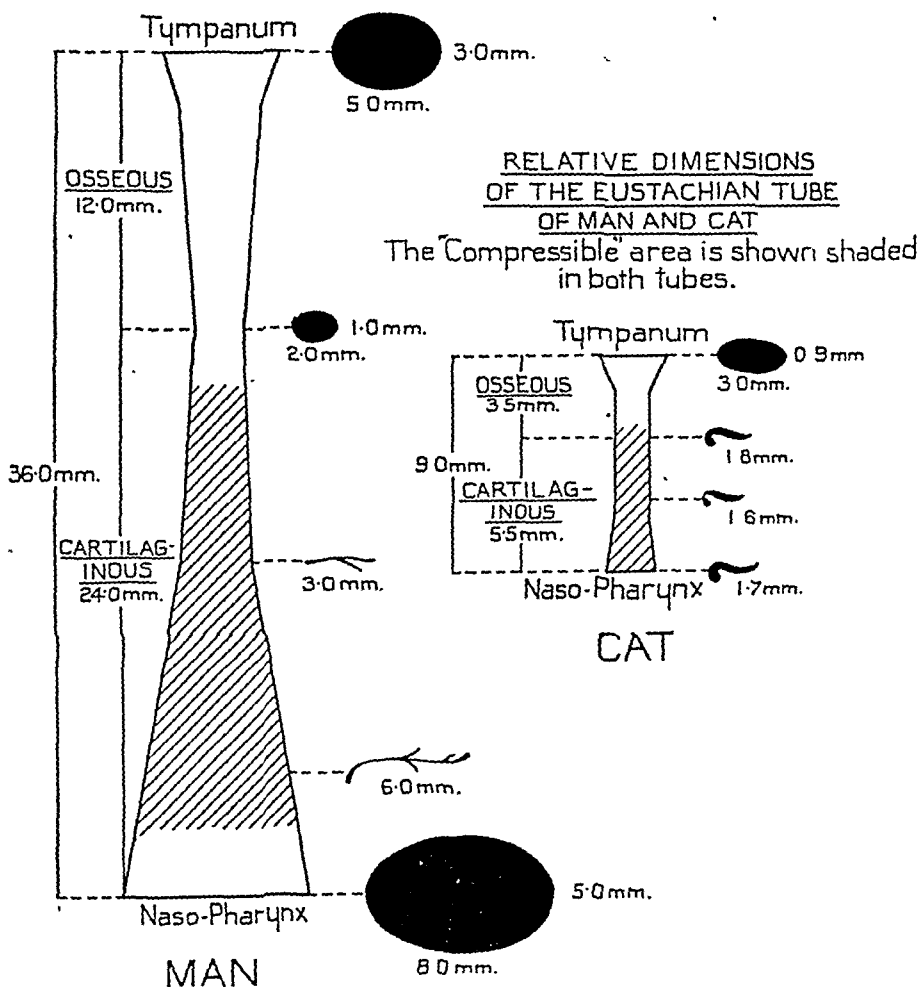


FIG. 14.

Diagram to show relative measurement of Eustachian tube of cat and man. The "compressible" area is shown shaded in both tubes.

Acute Otitic Barotrauma

THE PATHOLOGY OF EXPERIMENTAL ACUTE OTITIC BAROTRAUMA (Squadron Leader A C P Campbell)

A series of eighteen cats was used in this investigation, made up of a group of eleven animals in which we attempted to reproduce otitic barotrauma and seven controls

The first group were anaesthetized by intraperitoneal nembutal, and we attempted, if necessary by repeated injections, to maintain a depth of anaesthesia sufficient to abolish the swallowing reflex till they were killed. By this procedure we hoped to prevent opening of the Eustachian tube, which is produced by swallowing. In one or two cases, however, the animals did swallow. When the cats were fully anaesthetized they were decompressed in the chamber at the Royal Air Force Physiological Laboratory to a pressure corresponding to an altitude of 20,000 ft (350 mm Hg). They were kept at this pressure for periods varying from 2 to 5 minutes and were then recompressed to ground level atmospheric pressure.

The decompression and recompression were carried out at rates varying from 4,500 to 3,000 ft per minute, except in the case of two cats which, after decompression at the usual rate, were exposed to an "explosive" recompression (i.e. from 350 mm Hg to 760 mm Hg in one second).

Oxygen was given during decompression, starting at 586.4 mm Hg (7,000 ft), and continued till this pressure was reached again during recompression.

After removal from the chamber the animals were allowed to survive for periods of from 10 minutes to 24 hours, and were then killed by intracardiac nembutal.

Control group this consisted of two cats which were killed under anaesthesia without any exposure to barometric changes, and five cats which were anaesthetised, decompressed to an "altitude" of 20,000 ft and killed after 10 minutes at that altitude, without recompression, in order to find out what pathological changes, if any, might be produced by *ascent* in aircraft.

Immediately after the cats had been killed, the bullae and middle-ear cavities were opened to note the presence or absence of effusion, cultures (on blood-agar plates) were in some cases made from the effusion, and blocks of the relevant areas were then dissected out on each side, fixed in 4 per cent formaldehyde-saline, decalcified and embedded in celloidin. Sections were cut semi-serially at intervals of 400 μ , in a plane transverse to the long axis of the Eustachian tube. Sections from 20 to 30 levels from nasopharynx to middle-ear cavity were examined in each block. They were stained with hæmatoxylin and eosin, and in some cases by Masson's trichrome method and with phosphotungstic acid hæmatoxylin.

The pathological changes in the decompressed cats :

From Table I it may be seen that of the eleven recompressed cats, all but one showed changes of some degree in one or both ears. In eight cats the changes were bilateral. In some cases the changes seen, although in our opinion definitely the result of the recompression, were of such mild degree as to have been probably subclinical ; but in others they were severe enough to offer an obvious basis for the severest symptoms of acute otitic barotrauma in man.

In every case the changes affected predominantly the tympanum and bulla, and to a lesser extent the osseous part of the Eustachian tube in its funnel-shaped tympanic end. In no case were significant changes seen in the cartilaginous part of the tube, apart from effusion in the lumen which appeared to be due to passive drainage from the tympanum and bulla.

The changes seen were vascular in nature ; they consisted of congestion of the mucosa, hæmorrhage into the mucosa, cedema, effusion (sero-mucous or hæmorrhagic), and polymorph infiltration.

Some degree of *congestion* was the most common change seen, being present in 17 of the 22 ears examined. It affected more or less equally the mucosa of the tympanum (Figs. 20 and 22) and bulla, and to a less extent that of the tympanic end of the osseous tube, rarely extending as far as the isthmus.

Varying amounts of mucosal *hæmorrhage* were present in 11 of the 22 ears, affecting the same regions as the congestion. It varied from tiny petechiae to large confluent areas (Figs. 21, 23 and 24).

Cedema was seen, in the same situations, in 12 of the ears (Fig. 20). Slight degrees of cedema are difficult to recognize histologically and may have been missed in some of the remaining ears.

Effusion was seen in 13 ears. It varied from a purely sero-mucous to a very blood-stained fluid (see Figs. 23 and 24), and sometimes contained neutrophil polymorphs. In no case did it show fibrin (in sections stained with phosphotungstic acid hæmatoxylin). The effusion collected in the bulla and tympanum, and from these cavities it extended for a varying distance into the Eustachian tube. In the left ear of cat VII it filled the tube in its entire length and could be seen issuing from the nasopharyngeal ostium (Figs. 23 to 27). In most cases cultures were made from the effusions, but in none was any bacterial growth seen.

Neutrophil polymorph emigration was noted in 13 ears (Fig. 22). It was usually of trivial degree, but in one or two cases it was sufficiently marked to introduce a doubt whether a pre-existent infective otitis media was present. This question is discussed below. In most cases the vascular changes predominated so markedly over the polymorph infiltration as to make it seem obvious that the lesions were non-infective.



FIG 15

Normal tubal depression of cat $\times 20$
(Haematoxylin and eosin)

Note the prolongation of the cartilage in its floor

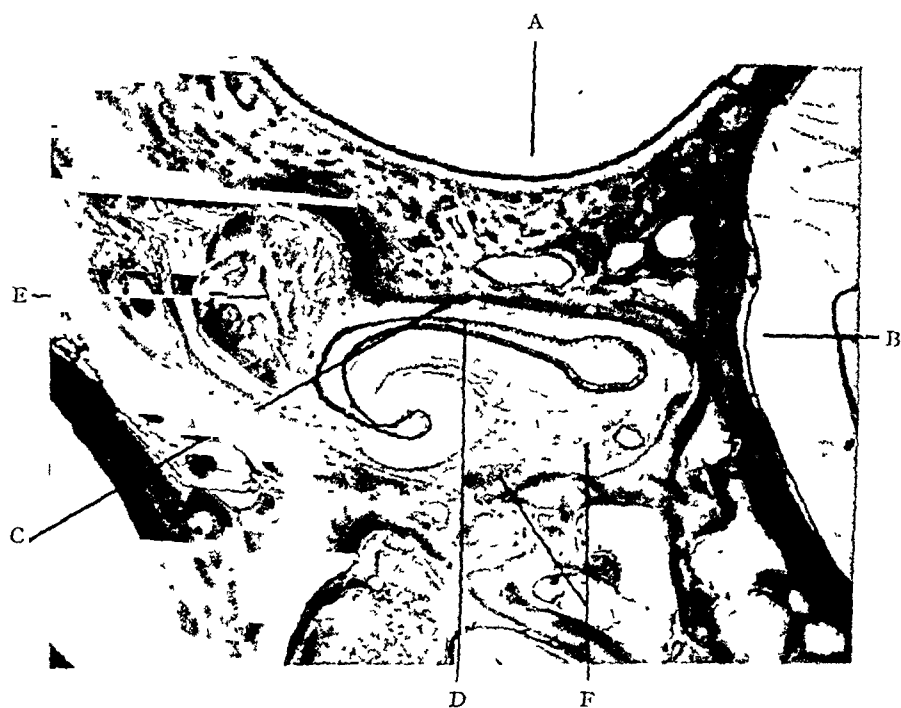


FIG 16
Normal tube of cat—osseous portion $\times 20$
(Hæmatoxylin and eosin)

- A —Middle ear
- B —Bulla
- C —Margin of bony canal
- D —Eustachian tube
- E —Tendon of tensor tympani muscle
- F —Nerves



FIG 17

Normal tube of cat—cartilaginous portion. $\times 15$.

(Hæmatoxylin and eosin)

Note the mass of mucous glands in both walls and below the tube



FIG 18

Normal tube of cat—nasopharyngeal opening $\times 20$

(Hæmatoxylin and eosin)



FIG 19
Mucosa of middle ear of normal cat $\times 290$
(Hæmatoxylin and eosin)



FIG. 20
Edema of mucosa of middle ear of cat (No 5) $\times 290$
(Hæmatoxylin and eosin)

great thickening and loosened texture produced by α -edema (compare 17) are also the presence of congestion, hemorrhage and leucocytic infiltration.

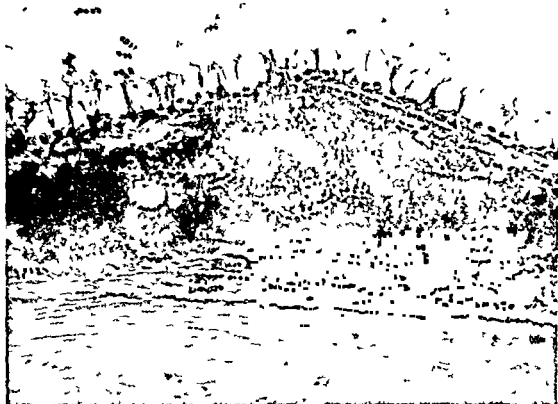


FIG 21

Confluent hæmorrhage into the mucosa of middle ear of cat (No 1) $\times 290$
(Masson's trichrome stain)



FIG 22

Polymorph infiltration of mucosa of middle ear of cat (No 11) $\times 290$
(Haematoxylin and eosin)

Note also the slight œdema and congestion



FIG. 23.

Effusion (sero-mucous fluid mixed with blood) into tubal depression of middle ear of cat (No. 1). $\times 20$.
(Masson's trichrome stain.)

Note also the hæmorrhage (dark staining areas) in the mucosa. Compare with Fig. 13.

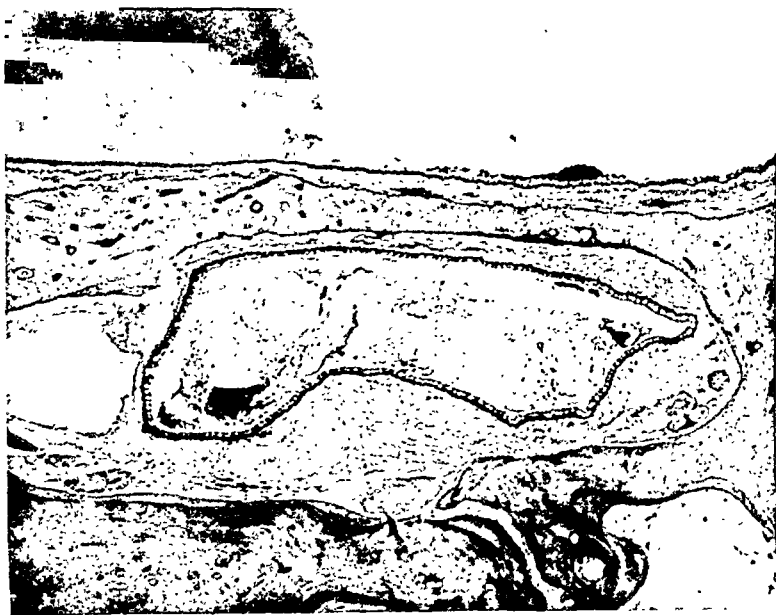


FIG. 24.

Tympanic end of the osseous tube of cat (No. 7) filled with effusion. $\times 28$.
(Hæmatoxylin and eosin.)

Note the mass of blood in the middle-ear cavity and small hæmorrhages in the mucosa of the middle-ear tube.



FIG 25

Lumen of the osseous tube of cat (No 7) filled with effusion $\times 28$
(Hæmatoxylin and eosin)

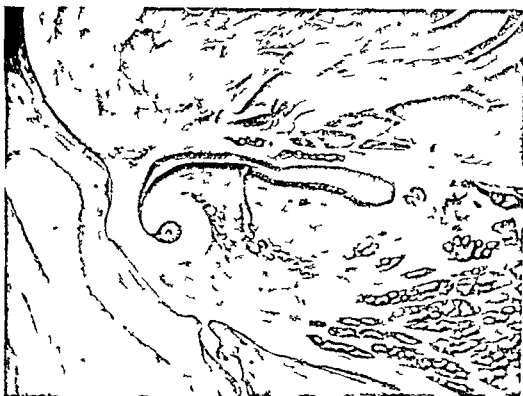


FIG 26

Lumen of the cartilaginous portion of the tube of cat (No 7) containing effusion $\times 28$
(Hæmatoxylin and eosin)

Note the mucous gland opening into the lumen of the tube



FIG 27
Nasopharyngeal ostium of tube of cat (No 7) filled with effusion. $\times 25$.
(Hæmatoxylin and eosin)

Pathological changes in the control cats :

The five animals killed " at height " showed no lesions which we could attribute to their " ascent ", and we have grouped them therefore with the two untreated cats as controls showing the range of naturally occurring pathological changes. None of these seven animals showed any sign of the acute vascular disturbance seen in the recompressed cats ; i.e. there was no effusion in the middle-ear cavity, and no hæmorrhage, œdema or congestion of the middle-ear mucosa. It has been suggested that middle-ear catarrh is not uncommon in cats, especially in winter, and some of this control group certainly showed inflammatory (including neutrophil polymorph) infiltration, presumably an infective reaction. But the sites affected were significantly different from those affected by the changes in the recompressed cats ; in two of the control animals a marked subacute inflammatory reaction was seen in the wall of the Eustachian tube, predominantly in the cartilaginous part, diminishing in the osseous part and affecting only slightly the immediately neighbouring mucosa of the tympanum ; there was a little pus in the lumen of the tube, but no pus or other effusion in the middle-ear cavity. Other ears of the control group showed an otitis externa with some inflammatory infiltration of the middle-ear mucosa immediately around the bony attachment of the tympanic membrane. But none of the controls showed any generalized inflammatory reaction of the middle-ear mucosa. So that infective otitis media would not seem to be sufficiently common to be invoked as a factor in the changes described in the recompressed cats, which as well as being much more of the nature of an acute vascular disturbance, had a very different distribution from those in the controls. Also, as we have already mentioned, all the cultures taken from the effusions in the recompressed cats were sterile.

Pathogenesis of the changes in the recompressed cats :

The vascular disturbance described—vascular dilatation, œdema, hæmorrhage, effusion—is comparable to the effects of " cupping " on the skin. It is all obviously explained by the production of a partial vacuum in the tympanum and bulla.

Hæmorrhage into the tympanum and bulla was very copious in some animals. Where invagination of the drumhead is marked it seems possible that a combination of rapid overdistension and longitudinal stretching may produce gross rupture of a vein or venule in the mucosa of the drumhead. In one cat (" explosive descent ") copious hæmorrhage into the tympanic cavity was found without much hæmorrhage into the mucosa, and in this case such a gross venous rupture may have occurred. But in most cases diapedetic hæmorrhages into the mucosa were also present in such a degree as to suggest that the hæmorrhage into the cavity



FIG. 27.

Nasopharyngeal ostium of tube of cat (No. 7) filled with effusion. $\times 28$.
(Hæmatoxylin and eosin.)

Acute Otitic Barotrauma

was produced by diapedetic "weeping" from the mucosa rather than by vascular rupture.

The polymorph infiltration found, if not due to pre-existent infective inflammation (as we think it is not) is presumably due to diapedesis from the overdistended vessels. One sees it in human lesions of vascular disturbance, such as infarcts, though not at so early a stage as it has been seen in our recompressed cats. The duration of the lesion in the cats seems too short to be compatible with a chemotactic stimulus to the polymorphs (the leucotoxin of Menkin, 1940) resulting from tissue damage. Possibly the "*vis a fronte*" force of the partial vacuum produces leucocytic diapedesis in a way that "*vis a tergo*" forms of vascular dilatation (as in infarcts) do not.

Correlation of these pathological changes with the symptoms of the human syndrome :

The degree of effusion and of mucosal oedema and hæmorrhage in these cats seems adequate to explain the persistence of the symptoms for a considerable time in human otitic barotrauma. None of our present series of cats was allowed to survive for more than 24 hours. We are at present examining a further series of animals surviving for longer periods to investigate the persistence of the pathological changes.

As for the mechanism of production of the pain, which, as pointed out above, may be independent of invagination of the drumhead, the distension of the mucosa by oedema and hæmorrhage would at first sight seem sufficient to cause painful stimulation of mucosal nerve-endings. But it seems unlikely that these changes could be reversed sufficiently quickly by the equalization of intra- and extra-tympanic pressures to explain the sudden relief given by this procedure, which has led us to suggest stretching of nerve-endings in the walls of the dilated vessels as a more likely cause of the pain, this stretching being obviously capable of quick reversal on restoring pressure equilibrium. We have already quoted work on the pathogenesis of migraine in support of this vascular theory of the origin of the pain. We have not, however, demonstrated nerve-endings in the walls of the blood vessels of the tympanic mucosa, or directly demonstrated their painful sensitivity to mechanical stimulation, so that our explanation remains purely theoretical.

We have seen no change in our cats to explain the persistent blockage of the Eustachian tube found in the human syndrome, apart from the presence of effusion on the tubal lumen ; it is possible that this effusion may be sufficiently viscous to produce some degree of blockage. Oedema, congestion and hæmorrhage in the tubal mucosa have been confined to the funnel-shaped tympanic end, and have never appeared to produce any obstruction of the lumen. It has been shown above, however, that the "compressible" area extends much further along the tube towards the

A. C. P. Campbell

tympanum in the cat than it does in man ; and this compressible area will not be subjected to the partial vacuum responsible for the mucosal swelling. In man, therefore, one would expect mucosal changes to extend much further proximally along the tube, possibly producing actual tubal obstruction from mucosal swelling.

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RADON TREATMENT FOR OTITIS DUE TO BAROTRAUMA

(PRELIMINARY REPORT)*

By MAJOR EDMUND P. FOWLER, JUN.,
Medical Corps, Army of the United States

DURING the last year, at a U.S. Army General Hospital, we have been treating and trying to prevent otitis due to barotrauma, with radon. When I first came into the Army I was struck by the number of American soldiers who developed large tonsils and adenoids. After they had been crowded together in barracks for some months, the Ear, Nose and Throat clinic of a neighbouring hospital was just like a clinic in a small boys' school. I was fortunate enough, a few months later, to see the same condition in England that I had seen in Maryland the winter before. The lymphoid tissue in their nasopharynxes was even worse over here. A large number developed recurrent otitis media especially after pneumonia, or a severe cold. Many of the men had colds all the time. It was quite apparent that the cases most susceptible to otitis media were those with large bands of lymphoid hyperplasia of the nasal and pharyngeal walls, just like children. When these were aviators it seemed to predispose particularly to so-called "barotitis", with high altitude flying or with dive bombing.

At first, I had used two 25 mgr. capsules of radium to shrink the lymphoid tissue about the Eustachian tubes of children, at the dosage recommended by Crowe¹ and his associates who used it for the same purpose. I have used deep X-ray therapy, which is as easy to administer as radium or radon.² Radon was used, through Professor Sidney Russ of the Middlesex Hospital, at the Central Radon Institute, Barton-in-the-Clay, Leicestershire, in 1942. 150 millicuries of radon was placed in two small tubes along the floor of the nose and left in place for 24 hours (Fig. 1). This gave a dosage of 66 milligram hours of radon per day, a dosage equivalent to the 2 gramme minutes of radium.³ If the patient had a cold, 33 milligram hours of radon were no reaction in two or three days, the remaining 33 were applied. One minor difficulty is the fact that radon decreases one-half in 3.85 days, and again one-half

* Before the Section of Otology of the Royal Society of Medicine, 1943. Moving pictures showing the application of radon were shown.

in another 3.85 days, so that at the end of four days, for example, it is necessary to leave the applicators in place 45 minutes (see Table I). Crowe is able to obtain up to 1,000 millicuries and he places one applicator on each side of the nose for two minutes the first day, and his second, third and fourth days are correspondingly shorter. Of course this saves much time but it is much more dangerous for operator and patient. 150 millicuries was the largest amount that we could obtain at one time in England.

In the past year we have treated 127 cases both Air Force and ground force with 66 mgr. hours, repeating if possible every three to six weeks,

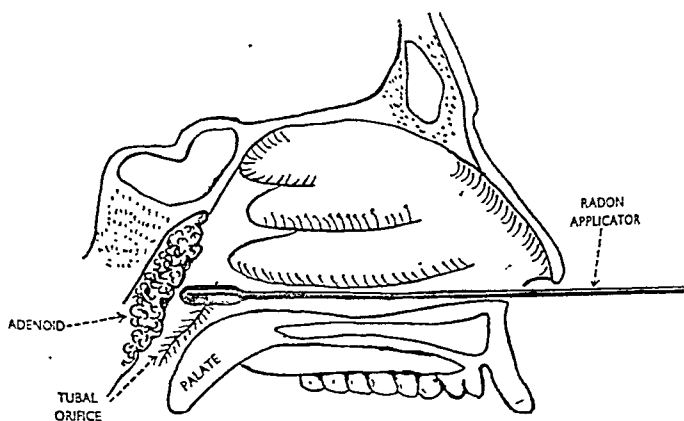


FIG. 1.

Position of one of the applicators in the nose and nasopharynx.

up to four or more treatments. There is rarely improvement before the third treatment, if 66 mgr. hours has been used. Unfortunately a great many received incomplete treatment or were lost to follow-up. The ground force is reported in this paper because it constitutes a control and in order to understand the difficulty of the flyers, it is important to know what happens on the ground. The airmen are, of course, a much more highly selected group than the ground force personnel and only a few of them develop otitis media while on ground jobs. None of them were deaf after their recurrent otitis cleared. On the other hand, 23 came to this General Hospital with a history of recurrent otitis media every time they were subjected to the barotrauma of airplane flight. Nine were treated with radon and given what was considered adequate therapy. Five of these have been returned to the air and are now carrying on operational missions without trouble. Six are still being treated or have not been followed long enough to be certain that they will not again develop otitis. The eight had incomplete treatments and were sent back to the States. We send them back to go to another theatre, if they never had trouble

Radon Treatment for Otitis due to Barotrauma

with "aero-otitis" at home and have intractable nasopharyngitis or sinusitis here. Three enlisted men of the nine well treated airmen have remained in England on ground duty; one because of nerve deafness which was not discovered until his catarrhal otitis cleared. I do not know why the other two gunners are not flying. One passed a pressure chamber test at 30,000 feet without difficulty; a fourth man still has some nasopharyngitis and cannot fly over 10,000 feet without trouble. He has been given an office job in an high altitude bombing squadron.

In the control group 31 of 35 or 88 per cent. were free from recurrent otitis media after four months if they received adequate treatment,

TABLE I

Showing increase in dosage time necessary each day with applicators containing 150 millicuries of radon on the first day. Such a table is made up each time the radon is delivered so that proper dosage for each date is available without calculation

April 1st	10 a m	66 mg hours.
1st day	4 p m	26 minutes
		27 ..
April 2nd	10 a m	31 ..
2nd day	4 p m	33 ..
April 3rd	10 a m	38
3rd day	4 p m	40
April 4th	10 a m.	45
4th day	4 p m	48

i.e. four to six treatments, 25 of 34 or 71 per cent. had sufficient improvement in their hearing to be returned to full field duty. This averaged ten to forty decibels for the range 512 to 2048.

The exact *modus operandi* of the radon is unknown. Whether the primary effect is entirely upon lymphoid tissue in and around the tube or whether the mild radiation also reduces the infection and secretion present I am not prepared to say. The reduction in recurrent otitis and drying up of low-grade catarrhal otitis in ground personnel was parallel to that which has been recorded by Crowe,¹ Farrior,⁴ myself,² and others.³ The dramatic effect on flyers who as a rule had no residual retraction and scarring of the drums was not surprising, for it is well known that lymphoid tissue is highly susceptible to radiation and most of the flyers only had a small amount to shrink away. This small amount apparently is enough to clog their Eustachian tubes if they fly high or change altitude rapidly. If once they are unable to clear their tubes while descending, œdema develops in the middle ear with more or less fluid and they may be grounded from two days to several weeks with aero-otitis as shown by Squadron Leader McGibbon. The radon apparently facilitates the normal function of the tube if lymphoid hyperplasia has interfered

with their proper opening and closing. It puts previously grounded airmen back in the air, even when they have had repeated severe otitis from barotrauma. With the less severe cases seen in station hospitals and on the fields it should do even better.

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The author was assisted in the examination and treatment of these patients by Captain Paul M. Osmun, U.S. Medical Corps, and in the details of radiotherapy by Lieut.-Colonel Robert P. Ball, Chief of the Radiology Service, 2nd General Hospital. To these men, acknowledgment and thanks are hereby rendered.

SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLOGY

Friday, December 3rd, 1943

President—DR. T. B. JOHNSON

Acute Otitic Barotrauma—Clinical Findings, Mechanism and Relationship to the Pathological Changes produced Experimentally in the Middle Ears of Cats by Variations of Pressure

The opening papers by Air Commodore E. D. D. Dickson, Squadron Leader J. E. G. McGibbon and Squadron Leader A. C. P. Campbell appear in this issue of the *Journal of Laryngology and Otology*, pp. 465-488.

DISCUSSION

to Air Commodore Dickson, Squadron Leader McGibbon, Squadron Leader Campbell

A. B. ALEXANDER: The name given to the condition to-day may well become its permanent designation and care and thought should be given to its selection. "Acute Aero-Otitis media" was a misnomer: histological evidence makes it clear that there is no inflammation, and therefore no otitis. "Otitic" barotrauma is, likewise, a misleading description. "Otic Barotrauma" is correct but cumbersome. The name "Tubo-tympanic pressure syndrome" corresponds best to the changes as demonstrated by Colin Campbell while at the same time fitting in to our usual otological terminology.

Lieutenant-Colonel NORTON CANFIELD (U.S.A.M.C.) said that he had examined the microscopic slides and had talked with the authors about the various pathologic changes. It had been mentioned that there were certain types of pain which occurred in the ears during changes of pressure. From personal experience in the pressure chamber he could say that these pains were extremely severe and very real and that they did originate from some source other than the tympanic membrane. With a completely anesthetized tympanic membrane, pain of a rather different type actually did occur. Owing to the work done by the R.A.F. officers they in the American Forces had instituted a programme of work on the same lines in an attempt to collect some human material which would be compared with the material so ably demonstrated in the laboratory animals.

He had also followed with much interest the work of Major Fowler in the use of radon for the treatment of this condition. They all realized that this type of clinical research had many vicissitudes and that various phases

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still needed evaluation. What did he think might be the proper method for having some control cases in this group? He was not clear about the selection of the cases to which radon should be applied, because there might be patients in whom the lymphoid tissue of the Eustachian tube might be entirely out of their vision. Some people with a good deal of lymphoid tissue in the nasopharynx could do their flying. It would be interesting to know more about seasonal changes. He had thought often of the possibility of a functional test by a modification of the present pressure chamber test. Some criteria must be worked out so that the cases which would receive improvement from the use of radon could be ascertained.

Mr. H. V. FORSTER said that it was possible to demonstrate accidentally the effects of a partial vacuum in the middle ear if too much suction were applied through the Weber Liel intratympanic catheter when treating a case of exudative serous otitis media. This had happened to him when treating a patient only two days ago. There was pain and the whole drumhead and apparently the lining of the tympanum became brilliantly infected.

With regard to the treatment by radium of lymphadenoid tissue believed present in excess about the Eustachian orifice, many will have read of such treatment used in America in cases of juvenile middle-ear deafness. The exact function of this tissue in the upper respiratory tract was to him an obscure problem and a study of Kaiser's work of 1923 appeared to demonstrate the great difficulties of a subject so important in the specialty of Otology.

He had feared to use radium in the nasopharynx in cases of juvenile deafness because it was rather a potent therapeutic weapon and we had not yet had time to hear of its late effects. There were delicate structures not far away including the pituitary body.

Captain BROWN FARRIOR (U.S.A.M.C.) said that since 1939 he had been using radium in Michigan for the treatment of deafness. He showed a number of lantern slides illustrating the conditions treated, in which there was marked œdema of the lymphoid tissue and inflammatory obstruction of the Eustachian tube. This was reduced by small doses of irradiation. The radium applicator was a standard 50 mgr. radium capsule. It was slightly grooved at the end, and was inserted in a manner similar to the insertion of the Eustachian catheter. The patient was anæsthetized with cocaine. He showed a slide indicating the audiometric improvement in hearing following upon this treatment. The indications for radium therapy were the first signs of any partial obstruction of the Eustachian tube, an audiometric loss of higher tone frequency, and a history of acute otitis media. A good result particularly might be expected in those cases of retraction of Shrapnell's membrane with loss of higher frequencies in which there was good action of the tympanic membrane with Siegle's speculum. He was very much indebted to Major Fowler for introducing the radon treatment.

Dr. E. A. PETERS referred to an extreme case of patency in which at every breath the drum could be seen to move in and out in an extraordinary way. Several years ago he had called attention to the importance of removing adenoids in cases in which there had been a catarrhal or suppurative otitis, particularly the adenoid tissue on the anterior wall of the fossa of Rosenmüller,

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which is attached to the Eustachian tube The results of so doing had proved very successful, so much so that he used to carry it out as a routine operation It was most useful, he found, to use Meyers ring knife, Meyers was the first man to remove adenoids he operated it through the nose It was extraordinary how suppurating ears would settle down with very little trouble The left forefinger placed in the nasopharynx readily located the fossa and guided the ring knife

Major FOWLER said that he had been interested in Air Commodore Dickson's remark about change of pressure His own experience had been of men who carried on quite well at a certain altitude, but experienced difficulty on coming down to a lower level The same thing had been repeated in the pressure chamber, and he had been unable to explain it or to find anybody who could explain it If the plane were put into a power dive from 40,000 ft it might be that the air was too light to push it through

Air Commodore E D D DICKSON in reply said that the first question of Major Fowler concerned the bringing down of people from high altitudes Changes in atmospheric pressure are greater for a given descent at lower than at higher altitudes His own experience was that symptoms were likely to be more severe when descending rapidly at lower altitudes Symptoms are often first noticed at about 17,000 ft

Squadron Leader McGIBBON, also in reply, said that nearly all the cases they had seen were among air crew flying in heavy aircraft and who did not fly at very high altitudes It was explained that when they started to dive at a height the Eustachian tube was opened and a great rush of air into the middle ear was admitted this rush of air on a rapid dive might be very great

Major E P FOWLER, also replying concerning his own paper said that he did not know how to make therapeutic clinical control It was extremely difficult The only thing he could say was that the men who had not been able to fly for months were able to fly again He agreed with all those who had said that they were not sure that the lymphoid tissue was the whole story He was not impressed by the changes in lymphoid tissue *per se* in radiotherapy, but he was impressed by the fact that cases which formerly had catarrhal trouble no longer had trouble of this type

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